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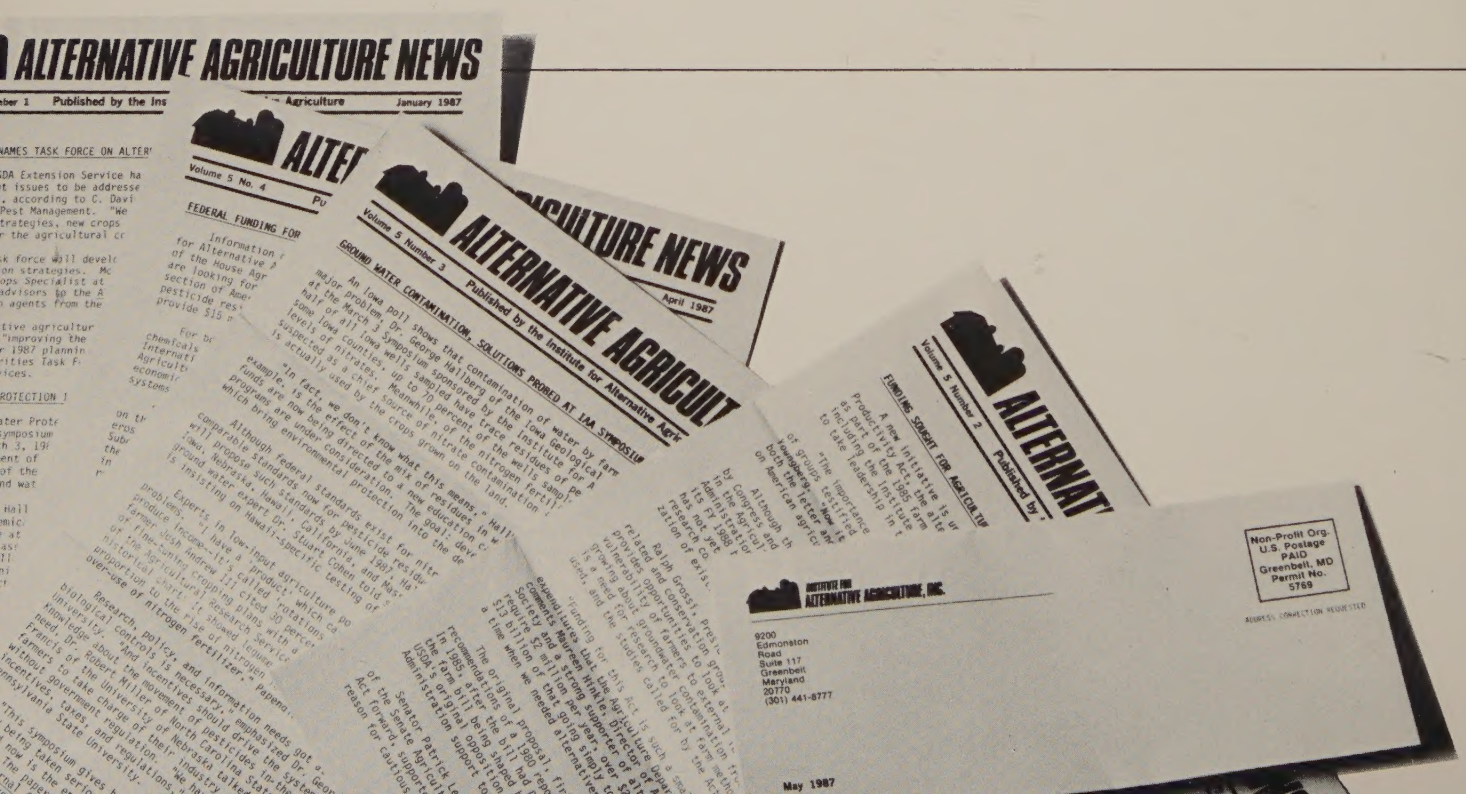

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The Institute for Alternative Agriculture is a nonprofit, tax-exempt research and education organization established in 1983 to encourage and facilitate the adoption of low-cost, resource-conserving and environmentally-sound farming methods. It works closely with producer groups, public research and education institutions, and government agencies in promoting a sustainable agriculture system.

Its programs include providing a national information clearinghouse, serving as a voice for sustainable agriculture in Washington, and developing and implementing research and educational outreach programs. It holds an annual scientific symposium and publishes a monthly newsletter.

The Institute is governed by a grass roots Board of Directors, which includes several commercial-scale organic farmers, and maintains a small professional staff. It is supported by memberships and donations and grants from foundations, corporations, and individuals.

Cover Photo

The cover photo shows a Jersey cow drinking at a movable water tank used in rotational grazing on a dairy farm in Maine (see p. 35). A single strand electric fence divides the pasture into small paddocks, which are grazed consecutively for one to two days. In the background is a recently mowed section of pasture. Photograph by Susan Gage, School of Nutrition, Tufts University, Medford, MA.

OPINION

Substituting management for cash inputs in organic systems

Jim Bender

The common assertion that organic farming replaces some cash inputs with management is sometimes taken as an indirect way of saying that it requires more labor as well. This is an unfortunate assumption because it makes organic systems seem less appealing. True, organic farming systems do replace some cash inputs with labor. However, they are impressive in the way they replace some of the inputs of conventional systems with pure management.

I will illustrate this important point with an example from each of the four seasons, plus a more general contrast between organic and conventional systems. The examples compare a typical diversified organic farm to a conventional corn-soybean system. The idea underlying all these examples is that, while achieving a particular goal in a conventional system might require direct expenditure of cash or labor, this same goal might be achieved on an organic farm as an additional consequence of a method chosen for other reasons, to achieve goals common to both systems.

Spring: Soil compaction

Soil compaction is a pervasive problem in contemporary agriculture. The main technique to deal with it in conventional systems is deep tillage with implements designed largely, or exclusively, for that purpose, such as chisel plows and subsoilers. The required labor and machinery are significant cash costs.

In contrast, a typical organic farm can use a very different, indirect strategy. This system will include legumes in its rotation for reasons that typically include fixing nitrogen, providing feed or ground cover, bringing trace minerals up from the subsoil, increasing the number of earthworms, and improving soil tilth. These are sufficient reasons for raising legumes. However, their deep, penetrating roots also help reduce the problem of soil compaction. Soil scientists disagree on just how much, and for how long, legumes reduce compaction compared to tillage. But both clearly help in different ways. Because the labor and expense of growing legumes is already justified by the benefits mentioned earlier, their contribution to ameliorating soil compaction can be regarded as free.

Summer: Weed control

The problems of weed control vary with the season, as d the opportunities for dealing with them. A serious limitatio of conventional chemical weed control is that it requires substantial commitment of money and effort at the beginnin of the growing season. This precludes cutting costs by adjustin to actual conditions later in the season.

A good organic sytem will maximize its flexibility in re sponding to changing conditions through staggered planting In growing soybeans, for example, a prudent organic farme will not follow the conventional practice of planting the entir crop as quickly as possible, but in a sense will plant it as slowl as possible. The total soybean acreage will be planted in mucl smaller units, with as much as several days allowed to pas between when successive units are planted. This allows th organic farmer to be in the best position to cope with a we season or to take advantage of a dry one. In a wet seaso different fields will have different conditions; there will be mor time to tend to fields with cultural methods because of th pauses between plantings. Because of the staggered planting the farmer will have time to give extra attention to weed contro if wet conditions make weed problems especially serious. Als in a wet season, because of the staggered planting, only som fields will have the severest weed problem; the farmer can giv these fields extra attention. In a dry season, when weed prob lems are not so severe, the farmer can do as little as is necessar to control weeds, perhaps only one cultivation, with no rotar hoeing or harrowing.

There are two important points to be made here. First, th organic farmer's strategy for coping with the uncertainties c weed control arises automatically from the staggered planting It does not cost more, it requires virtually no additional labo and often will improve yields. Second, in dry years, when wee control is less of a problem, the organic farmer is in a bette position to take advantage of this situation, to avoid some c the weed control costs to which the conventional system i already committed. Again, this comes from the managemen system, not from additional cash expenses or labor, in contras to the chemical weed control methods used on conventiona farms.

Jim Bender is an organic farmer near Weeping Water, NE.

continued on page

Biological recycle farming in the People's Republic of China: The Doudian Village experiment

Cheng Xu and James R. Simpson

Abstract. *An explanation is provided of why and how one group of researchers in a Chinese village setting came to focus on what the authors call biological recycle farming. An explanation of applied agricultural research in China is provided. One conclusion reached is that application of research at the village level was largely successful because it was founded on community development principles. Another conclusion is that food production in very marginal Chinese villages can be increased significantly. While the alternative approach discussed cannot be exported wholesale to many other countries of the world, the concepts are very useful for international economic and agricultural development.*

Key words: pond culture, Anabaena, blue-green alga, symbiont, Azolla, aquatic fern, swine feed, poultry feed

Background and purpose

There are many kinds of farming systems and approaches to agriculture and animal husbandry in the world. The diversity of these systems becomes especially evident when the subject is examined from an historical perspective. Numerous reasons for the diversity in systems are evident, i.e. matters relating to economics, ecology, climate, geography, cultural factors, technological base, government policies, and population pressure (Simpson, 1988). In the Peoples Republic of China ("PRC" or "China") there has been a long history of experimentation in agriculture, this particularly with variants of organic farming (King, 1968). The primary purpose of the present article is to explain why and how one group of researchers in a Chinese village came to focus on what we here call "biological recycle farming." A secondary objective is to foster a better understanding of applied agricultural research as it is currently being practiced in China.

A major problem confronting China over the centuries has been limited arable land. At the local level, farmers in the agricultural areas continually developed improved cropping systems, but these systems barely provided a subsistence living for the farmers and their families. Production was always hopelessly inadequate to meet government tax demands. In feudal times, much of the production went to the court; in more recent times, a portion of production has been required of all farmers for community (commune, or more recently, township) purposes.

Agriculture in China has, until the past decade, been based on organic farming principles. Human wastes, animal manure, green manure crops, and a wide variety of crop by-products such as cottonseed meal have provided the bulk of crop nutrient requirements. But in the late 1980's, an expanded cadre of scientists, political decision makers, and farmers has come to accept chemical fertilizers as the key to greatly expanded output.

Greater use of fertilizer and improved agricultural machinery, new varieties of seeds, shifts in cropping systems and management, i.e., technological change in its broadest sense, have temporarily moved China from the chronic fear of famines just two decades ago to a level of self-sufficiency in foodstuffs. Several nagging problems, however, persist. China's 1.1 billion people still live on the edge of food shortages. There are many rural areas where many of the people live on nutritionally inadequate diets. Perhaps most troublesome of all is the perception by government officials that projected economic growth will have to be accompanied by a greatly expanded supply of livestock products to meet expanded consumer demand (Table 1). Feedgrain requirements will thus have to grow dramatically.

China's central planners have recognized the likelihood of expanded demand for livestock products along with

Table 1. Consumption of livestock products in the People's Republic of China in 1985 and targets for the year 2000

Item	1985	2000
	------- kg per capita --------	
Beef	0.60	1.15
Pork	15.90	21.20
Mutton	0.29	0.60
Poultry	19.43	27.89
Fish	6.70	14.40

Source: Adapted from the 6th 5 Year Plan, Peoples Republic of China.

Cheng Xu is Associate Professor and Director, Research Institute of Integrated Development of Agriculture, Beijing Academy of Agricultural and Forestry Sciences, P.O. Box 2449, Beijing, Peoples Republic of China. James R. Simpson is Professor, Food and Resource Economics Department, McCarty Hall, University of Florida, Gainesville, FL 32611.

Table 2. Comparison of animal feedstuff requirements in 1985 and 2000

Item	1985	2000	Percentage Increase over 1985
			--- Pct ----
Low Population Growth			
Metabolizable Energy (Billion Mcal)	1,957	3,010	53.8
Crude Protein (Million MT)	93	148	58.5
High Population Growth			
Metabolizable Energy (Billion Mcal)	1,957	3,046	55.7
Crude Protein (Million MT)	93	144	54.2

Source: Author's estimates from a feed balance sheet computer program, and based on government targets for the year 2000 (Table 1).

concern about improving nutritional needs by setting targets for livestock product consumption in the year 2000. If the targets (Table 1) are to be met, metabolizable energy (ME) requirements during the period 1985-2000 will have to increase by about 54 percent, while crude protein (CP) requirements will increase by about 55 percent (Table 2). Fulfillment of government targets requires that human consumption of protein would increase about 40 percent from 1985.

Part of the nagging problem about food production goes back to the age-old limitations on land and other natural resources. Yet, while many solutions for greatly expanded output per hectare are well recognized and are being adopted as rapidly as capital constraints can be overcome, major remaining barriers include farming systems adjustments, demographic reorganization, and very real ecological concerns. Recognition of these apparently mundane--yet crucial--barriers led to initiation in 1977 of the Doudian experiment. This project is now becoming widely recognized as a success in applied research.

For a general background on the entire subject, readers may consult Anon (1979).

Specifics from the Doudian Village

Doudian is a village with a population of 1,040 households covering 380 ha of arable land about 50 km southwest of Beijing in the North China Plain. The principal crops, in what was one brigade of a commune until 1981, continue to be wheat and maize. As a result of intervention by on-farm researchers, annual grain output increased from 1,720 metric tons (MT) in 1977 to 3,200 MT in 1986. Annual per capita income of this former slum village has increased 16-fold since 1977, i.e., from an equivalent of 25 U.S. dollars per capita to one of 400 at present (unadjusted for inflation).

Researchers from the Beijing Academy of Agricultural and Forestry Sciences, who in reality are what the community development literature defines as "change agents" but with a technical background, realized that the major goals were to greatly expand grain and livestock product output. These specialists, who are researchers with a small amount of extension obligation, foresaw the village as a microcosm analogous to an independent economy. In effect, the tactic was to expand grain output to 1) meet village human needs, 2) produce a surplus which could be sold to secure cash for inputs and capital investments, and 3) expand feed grain output. Livestock became a central focus, both as a means to improve protein availability for villagers and as a contribution to cash earnings.

The key problem addressed was improvement of cropping systems, especially the introduction of double cropping. Evaluation of double cropping systems revealed that despite increased cropping the intensity of insect problems did not increase. Weeds are effectively controlled by plowing twice prior to planting winter wheat and by application of 2, 4-D to winter wheat. Summer weeds are controlled by residual chemicals and by competition from rapidly growing and high-density maize.

Proper timing was recognized some time ago to be critically important to the success of these more intensive systems. Thus, the solution was to expand on a large scale. At first, great resistance was met through belief that heavy human population density and a large labor force precluded mechanization. In other words, it was felt that employment as a farmer, however unproductive, was better than the only other apparent alternative--being idle. This thinking was overcome by development of village enterprises.

By 1983, 24 village-run enterprises had been developed which produce such varied products as garments (like windbreakers and raincoats for export), prefabricated concrete parts, bricks, carpets, and handicraft items. Eighty-five percent of the labor force has been transferred from field work to village-run operations including agricultural

Table 3. Crop production costs and returns, Doudian Village, 1977 and 1986

Item	1977	1986
	---------- $US/Ha----------	
Fuel	2.10	31.00
Machinery depreciation	3.00	54.50
Chemical fertilizer	150.00	165.00
Irrigation electricity	25.00	27.00
Pesticides	10.00	1.50
Labor[a]	170.00	425.00
Other	24.50	31.80
Total	384.60	735.80
Income	474.60	1,035.80
Net return	90.00	300.00

[a] Daily wage, $US 0.27 in 1977 and $US 1.08 in 1988.
Source: Data from author files.

Table 4. Sample agricultural production indexes in Doudian Village, 1985 and 1987

Item	1977	1985	1987
Grain			
Area (ha)	303	280	280
Output (kg/ha)	5,752	11,160	12,015
Village			
Production value ($US 1000)	360	4,220	5,000
Agricultural share (Pct)	51.6	20.6	27.2
Income per laborer ($US/year)[a]	29.00	350.00	400.00

[a] Exchange rate $US 1.00 = 2.72 Yuan prior 1985.
$US 1.00 = 3.71 Yuan after 1985.

Source: Data from authors files.

and livestock related enterprises such as a slaughterhouse, cattle feedlots, broiler and egg production, and a dairy unit. A critical factor has been the linking of farm services, such as providing tilling and harvesting equipment with a community-wide effort to expand income savings for village use rather than just as an individual or personal activity.

A crucial point is the recognition of Doudian's growth as a community-led project. At the project's inception, the village was organized as a commune, with essentially no free enterprise, not even individual marketing of garden products such as vegetables. The village prospered because strong leaders with a real interest in the village were chosen. Doudian is similar to much of rural China, where 70 percent of the population is either illiterate or has only a primary school education. Another element has been availability of long-term community development specialists with appropriate technical training. It is important to recognize that virtually no outside funds were injected into the village and that the key problem--lack of mechanization to permit adoption of multiple cropping systems--was correctly identified and overcome. Doudian is the first successful example of multiple cropping with mechanization in North China.

Grain production has been increased dramatically and is nearing maximum economic output with current technology. Maize yield is 6,450 kg per ha compared with an average of 3,607 kg in China and 7,406 kg in the United States. Wheat output is 4,950 kg compared with an average of 2,937 in China and 2,519 kg in the United States. The dramatic crop production yields have been accompanied by higher costs per ha as purchased input use increased (Table 3), but net income has also increased as have labor efficiency, labor income, and output (Table 4).

The question that arose a few years ago was what to concentrate on next--especially given the greatly expanded input use. A whole host of individual experiments such as optimal age to place cattle on feed, ammoniation of wheat straw and hay, mixing poultry litter in silage, and fine-tuning the dairy and egg operations were in place or planned for the near future. It was determined that, while yields had been increased dramatically through the use of chemical fertilizers and a variety of energy-using inputs, China's ecological system would suffer greatly if this micro level system, apparently a very successful experiment, became practiced throughout the arable areas of China. For example, application of crop and manure residues is an alternative as the recovery rate of N and P is relatively high from them, 55 and 65 percent respectively. Dependence on heavy chemical fertilizer application would mean that agriculture would be contributing to an eventual energy crisis (Hodges and Scofield, 1983).

Perhaps an even more serious problem is concern about pollution. Heavy input of inorganic energy, especially in chemical fertilizer, combined with a highly intensified animal husbandry, could cause environmental problems such as leaching and enrichment of nitrates in underground and surface water, as well as odor. These problems have become very important recently because more and more medium and large scale chicken/dairy farms are being built around the suburbs of China's big cities. Manure from them is being recycled onto cropland.

Introduction of livestock into the village as a major production complex is beginning to yield considerable by-products, most notably manure. In 1977, no cattle were being fed and there were only 2,000 layers and 700 hogs. By 1987, the village was fattening about 2,700 head of cattle annually and had 40,000 layers and 2,500 head of hogs. The lesson of thousands of production cycles in which nature has harmoniously co-existed with humans was drawn upon, albeit in a subconscious fashion, and a biological cycle farming system devised.

The routine cycle in which feedstuffs are fed to livestock and poultry and manure is used for fertilizer was modified by introduction of a 400 cubic meter mesophilic biogas plant, which can treat manure from 600 head of cattle daily (Figure 1). About 250 cubic meters of biogas generated daily is an amount sufficient to power a 300 KWH generator which now provides electricity for the entire egg operation as well as for part of villager needs. Expanded methane production will be used to provide electricity for other nearby farm and manufacturing activities.

Table 5. Consumption of concentrate for each kg of swine weight gain in different rations mixed with biogas sludge

	Live weight		
	30-70 kg	70-85 kg	30-85 kg
	kg of concentrate		
Control	3.81	4.42	4.01
7 pct sludge and 93 pct concentrate	3.74	4.45	3.99
12 pct sludge and 88 pct concentrate	3.67	5.27	4.03
17 pct sludge and 83 pct concentrate	3.55	4.33	3.83

Source: Data from author's trials.

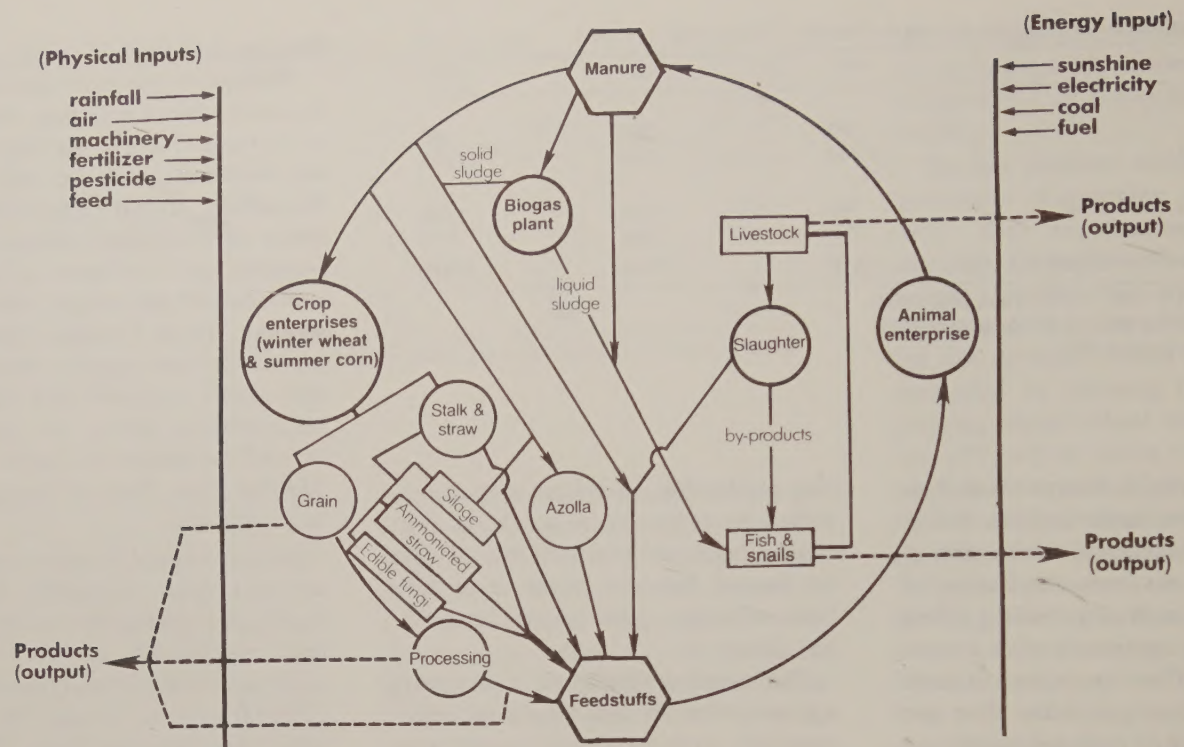

Figure 1. Principal food-chain (physical recycling) system in Doudian Village, China.

As of mid 1988, the biogas plant was operating at 100 percent of capacity and producing about 45 tons annually of liquid sludge which, along with poultry manure and waste blood from animal and poultry slaughter operations, feeds fish and snails (*Ampullaria gigas* sp.). Snail meat has about 14.5 percent protein (fresh weight basis) and the shell is rich in calcium and magnesium. It appears possible to use finely ground snails as a partial substitute for imported fish meal. As of mid 1988, about 5 tons of fish and 0.1 tons of snails were produced from 3 ha of ponds.

Solid sludge from the biogas plant replaces 12-15 percent of the concentrate used in swine rations (Table 5). This is of great importance as pork is the principal meat consumed in China, and the swine industry uses over two-thirds of available feed grains. The remainder of solid sludge is used as bio-fertilizer. Night soil is used for compost.

Poultry manure is added to silage which in turn provides a feedstuff for animals. Crop residues such as wheat straw and maize stalks, ammoniated to improve digestibility, are provided to animals as edible feedstuffs or are turned into silage.

Another significant biological recycle farming experiment is production of so-called "fungi-bran feed" using corn cobs, which previously had little value, as the cultivation substrate of mushrooms. The substrate is fed to hogs after mushrooms have been harvested several times.

Most of the techniques used in Doudian are well known in the West; an exception is growing azolla (*Microphylla*), an aquatic plant community consisting of a fern and symbiotic blue-green algae (*anabaena-azollae*) which fixes its own nitrogen and requires only additional phosphate. Little known in the western world, it has been used in China for centuries as a green manure crop. In the Doudian experiment, it covers the ponds where the snails and fish are grown and is provided with additional phosphate from the liquid sludge. It reproduces very quickly by means of highly effective photosynthesis and nitrogen fixation.

In a cultivation experiment at the village, azolla, which can only grow in the Beijing area for 6 months as it is not resistant to cold weather, yielded 50 tons (fresh weight) per hectare of water surface. Yield on a dry weight basis is 19.5 tons, which is about twice that of alfalfa (dry matter basis). Crude protein content on a dry matter basis is 11 percent. Trials show it to be promising as both a poultry and swine feed by mixing with concentrate rations. There are just 20 ha of ponds in Doudian, yet this is the largest experimental or commercial application in China.

For an overview of the interrelations of various factors, readers are referred to Figure 1.

Considerations relevant to agriculture in China in the future

Concerns about ecological pollution cannot be over-emphasized. Newspaper stories are common, and it is high on the agenda of both decision makers and agricultural researchers. A partial alternative to heavy fertilizer application must be found, not so much because of concern about soil fertility as ground

water contamination. A very real dilemma exists as decision makers, with their macro view, realize the need but farmers, with their micro view look at labor effort as part of the decision about whether to choose organic or chemical fertilizers. As farmer incomes have increased, they have rationally (from an economic perspective) leaned toward chemical fertilizers.

Data on utilization of organic fertilizers are not available. However, some estimates of additional organic fertilizer can be made by recognizing that total consumption of livestock products is expected to increase between 25 and 44 percent between 1985 and the year 2000 at the national level (author's estimates). Those growth rates represent the maximum additional possible availability of organic fertilizers from animals. Human population will also increase about 15 percent over this period. Thus, more human waste will be available. As is shown in Table 2, however, animal feedstuff requirements will increase more than 50 percent over the same period. The recovery rate and availability of animal manures and human wastes are not sufficiently large enough to meet this demand. Moreover, the fertilizer value from these organic materials is relatively low. Consequently, chemical fertilizers will have to make up an even larger proportion of the plant nutrient requirement.

Total consumption of chemical fertilizers in China increased 17 percent in the four-year period 1982-1986 (Table 6). China has an ambitious plan to double its chemical fertilizer output by the year 2000 although that goal may not be reached because of insufficient investment funds (*China Daily*, 1988).

Chemical fertilizers in China generally have four price levels: (1) an official price controlled by the central government, (2) an official price controlled by local governments, (3) a negotiable price supervised by governments at all levels, and (4) a market regulated price. Previously, the price of chemical fertilizers was kept low by government subsidies to producers. Since the prices of many agricultural products, however, are no longer regulated due to the economic reform started in 1985, the state has lost its control over the fertilizer market.

Table 6. Chemical fertilizer consumption in China, 1982 and 1986

Fertilizer	1982	1986	Percent increase
Nitrogen	44,126	52,966	20
Phosphorus	20,953	20,926	0
Potassium	1,404	1,815	29
Complex	1,640	4,253	159
Total	68,123	79,960	17

Source: *China Agriculture Yearbook*, 1982 and 1987.

One main problem with fertilizer marketing is that factories sell their products at government-set prices while most farmers pay market prices. An exception is where the government provides fertilizers at official prices for scientific research and to compensate losses of farmers who sell their grain to the state at low prices. Apart from the two exceptions noted, the price difference becomes a subsidy to business people, mainly officials, who are able to get the fertilizer at official prices (*China Daily*, 1989). As a result of the price fixing, the factories have little incentive to produce more fertilizer, and farmers have little incentive to produce more grain. Fertilizer shortfalls will have to come from imports. Thus, even though organic fertilizers will continue to be used in combination with chemical fertilizers, the latter are the growth area. It must also be recognized that heavy loadings of organic materials can also pose an environmental pollution hazard.

One partial solution to both macro and micro views is biogas digesters and use of sludge as an organic or bio-fertilizer. Even at the most elemental level, feedstuffs--table scraps and vegetable waste--are being experimented with as a feed supplement for snails.

The techniques and results presented in this article, while interesting, are less significant than the fact that they are founded on community development concepts. Thus, as Chinese researchers move into the next phase, which is addressing national ecological and energy needs on a broad commercial scale, they begin with encouraging results. It appears that food production can be expanded greatly and pressure on natural resources reduced. In fact, variants of their "ecological farming" are now being researched in more than 200 counties in China.

However rich the results, objective analysis reveals that the Doudian experiment is somewhat unique in that its successes ironically hinge on the negative features which fostered it--heavy population pressure and very small land holdings, high input prices, and lack of development capital. Biological recycle farming works in Doudian because a large semi-autonomous highly disciplined village is the production unit as opposed to individual farms typically found in other developing or economically developed countries. In addition, it works because of the ecological conditions, cohesiveness, vision, and community development/technical assistance available through the provincial government. Despite these constraints, the approach can be replicated in China and has relevance for other nations, especially in the developing world. But, while this alternative approach to agriculture cannot be exported wholesale to many other areas, the concepts of a fully integrated approach are relevant. In the end, concepts are the key to development.

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Cultural practices for enhanced growth of young peach trees

D. M. Glenn and W. V. Welker

Abstract. *A review of orchard soil management effects on tree growth and soil parameters is presented. It shows the gap between present common practices and results achievable in other systems. An alternative soil management system for newly planted peach trees, termed "killed-sod", is described. This system has improved soil structure and rainfall infiltration and greatly increased early tree growth and yield. A fertilization study has demonstrated that the addition of a complete fertilizer in four different soil management systems could not account for the increased growth resulting from the improved soil environment in the killed-sod system.*

Key words: killed-sod, herbicide-strip, cultivation, runoff, soil structure, soil organic matter

Introduction

Several review articles have been written relating the influence of orchard soil management to tree growth, root growth, and soil parameters (Atkinson, 1980; Haynes, 1980; Atkinson and White, 1981; Hogue and Neilson, 1987). The findings to date may be summarized as follows.

1. A permanent sod cover in the orchard reduces tree vigor, yield potential, and soil nitrogen availability and also promotes shallow root development, while increasing or improving the status of soil organic matter, rainfall infiltration, soil water holding capacity, soil pH, and soil structure.

2. Mulching with an organic residue within the tree row increases tree vigor and yield potential, nutrient availability (depending upon the C:N ratio of the mulch), shallow rooting and overall root density, and soil organic matter in the surface horizon; it also improves water availability by reducing raindrop impact, surface sealing, and evaporation, and increasing rainfall infiltration. Mulching tends to maintain or slightly increase soil pH. An organic mulch increases the chance for vole activity and consequent tree damage.

3. Cultivation within the tree row increases tree vigor and yield potential relative to a sod cover except when soil erosion and the resultant loss of soil organic matter leads to reduced growth. Cultivation increases nutrient availability in the short term, but in the long term results in decreased soil nitrogen. Cultivation can increase available soil moisture relative to sod cover but reduces soil organic matter, soil pH, water holding capacity, infiltration, and soil structure, resulting in greater potential for soil erosion. Cultivation reduces rooting density in the tillage zone due to root pruning; this has been related to reduced growth in some studies.

4. A vegetation-free strip established with herbicides within the tree row increases tree vigor and yield potential, often more so than cultivation. It encourages rooting in the surface layers of the treated area, though less than under an organic mulched tree row system. A herbicide-strip increases nutrient availability because nutrients tend to accumulate in the surface layers, and increases available water relative to a sod cover. The herbicide-strip system reduces soil pH and organic matter and leaves a bare soil surface year-round that reduces rainfall infiltration and soil structure; it thereby increases the soil erosion potential, as with cultivation. Increased erosion is likely; runoff will contain crop protection chemicals applied to the trees but washed to the soil surface, as well as herbicides, and fertilizer material.

Presently the grassed-alley, herbicide-strip system is the predominant system in deciduous tree fruit areas of the world in spite of the fact that an organic mulch in the tree row with a grassed alley appears to be the best overall orchard floor management system. The reasons favoring the grassed-alley herbicide system are primarily economic (Hogue and Neilson, 1987). The cost for both materials and labor to develop an organic mulch system within the tree row are apparently not cost effective. Orchardists also have a concern that rodent damage to trees will occur when a thick organic mulch is present (Byers, 1984). The authors of the present paper have developed a soil management system termed "killed-sod" that attempts to bridge this economic gap for newly planted trees while providing the beneficial soil effects of an organic mulch with a reduced risk of rodent damage. This killed-sod system has greater potential environmental safeguards than the predominant herbicide-strip system.

This paper reports a summary of information relating to soil management effects on newly planted peach trees and an explanation of the soil fertility component responsible for the growth re-

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D. M. Glenn is Soil Scientist and W. V. Welker is Weed Scientist, USDA-ARS Appalachian Fruit Research Station, Kearneysville, WV 25430.

sponse seen in the killed-sod system.

Study sites and methods

The study sites were located at the USDA-ARS Appalachian Fruit Research Station near Kearneysville, West Virginia. The soil used was a deep well-drained Hagerstown silt loam (mixed mesic, Typic Hapludalf) on 1 to 5 percent slopes. The specific soil management practices and soil parameter measurements used are described in Glenn and Welker (1987, 1989) and Welker and Glenn (1988). Briefly, we compared the effect of a cultivated tree row strip, a herbicide-strip, a permanent Kentucky-31 (K-31) tall fescue (*Festuca arundinacea* Schreb.) sod cover, and a killed-sod strip on young peach tree growth and soil parameters. The peach trees were planted on a 6.5 x 4.5 m spacing with a 3 m K-31 grassed alley.

The killed-sod system is developed by first establishing a vigorous K-31 sod prior to planting of the trees. A preplant application of lime and nutrients indicated by soil and plant analysis can be incorporated prior to sod establishment. The objective of sod establishment is to develop *in situ* biomass that can be killed prior to planting. In our experience appropriate levels of biomass can be developed by growing a sod cover and killing it with herbicides before planting. Alternatively, high-temperature steam or flame could be used to kill the sod or a spring grain cultivar planted in the late summer which would winter-kill, thus providing suitable levels of biomass. The length of time to establish the sod varies by region and management practices, but the objective is to develop at least 200 g dry matter/m^2 or sufficient residue that will persist and provide 80 percent soil coverage for two or more years.

An additional study was initiated in 1984 to determine the effect of fertilization and soil management systems on newly planted peach tree growth. Four soil management systems were evaluated. The *cultivated* treatment consisted of a 3.5 m strip continuously cultivated since 1982. The *plowed sod* had a K-31 sod established in 1982 and a 3.5 m strip; it was plowed and disked in October, 1984. The *seeded grass* treatment was cultivated beginning in 1982 and then seeded with K-31 at 40 kg/ha in October, 1985, resulting in 40-60 percent ground cover. This grass was killed with glyphosate shortly after tree planting. Glyphosate is a herbicide with minor environmental impact since it hydrolyzes rapidly into harmless degradation products. The *killed sod* treatment had a K-31 sod established in 1982; it was killed with glyphosate shortly before planting in 1985, resulting in 100 percent ground cover. Weed control in the killed-sod and seeded grass treatments was maintained with a residual herbicide treatment applied each spring (1.12 kg/ha diuron + 1.12 kg/ha terbacil). Alternatively, glyphosate could be used during the growing season for weed control. Further research is needed to develop alternatives to suppress weed growth, such as the use of high-temperature steam or the use of a grass that would leave an allelopathic residue and eliminate the need for a residual herbicide. Peach trees with Redhaven scion on Halford rootstock (*Prunus persica* (L.) Batsch) were planted in the center of the 3.5 m treatment strip in May, 1985. Fertilizer treatments were no fertilizer added and split applications of 10-10-10 equivalent to 20 kg N/ha/application, applied in May and July each year in 1985 and 1986. The experimental design was a split plot with soil management treatment as the main plot and fertilizer level as the subplot. There were two trees/subplot. Total above-ground wood weight was determined after leaf fall in November, 1986, by cutting the trees 30 cm above the ground and weighing the trunk and scaffold limbs. Soil organic matter content in the 0-30 cm depth was determined by the loss of carbon on ignition (Welker and Glenn, 1988). Four subsamples/subplot were pooled for a composite sample.

Results and discussion

The development of soil management systems that promote young tree growth and make efficient use of natural resources is needed in present orchard production systems. An organic mulched tree row is recognized as a better soil management system than the herbicide-strip, but economics and vertebrate pests prohibit its implementation (Hogue and Neilson, 1987; Byers, 1984). The killed-sod soil management system was developed as a substitute for the organic mulched tree row because it (1) reduces the mole and rodent problem associated with heavy residue around deciduous fruit trees. Heavy residue can serve as a winter habitat for rodents that feed on the bark and roots of the trees. The killed-sod trials at the Appalachian Fruit Research Station have shown no rodent damage because there is insufficient residue (< 480 g/m^2) in the killed-sod treatment to serve as a habitat; and (2) creates a soil environment similar to that of an organic mulched soil. We have found that compared to cultivated and herbicide systems the killed-sod system maintains a lower soil bulk density, greater macropore space, aggregate stability, and water infiltration capacity and higher soil organic matter level and microbial activity (Welker and Glenn, 1988). Soil microbial activity is the most effective means of decomposing exogenous hydrocarbons, and even the slightest increase of soil organic matter will increase microbial activity (Kearney and Helling, 1969). The dead grass root channels in the killed-sod system provide a direct passage for the infiltration of water and presumably for rapid gas exchange within the soil matrix, although we have not measured the latter parameter. The killed-sod residue prevents raindrop impact and surface sealing of the soil, thus resulting in greater rainfall infiltration and reduced runoff (Glenn and Welker, 1989). It also results in lower soil temperature during high temperature periods but does not seem to increase the risk of frost damage on nights with radiative heat loss (Glenn and Welker, 1987). These soil factors interact to create an environment conducive to tree growth with greater environmental safeguards than prevails in the predominant herbicide-strip system.

We have shown that tree growth can be increased 120 percent during their first three growing seasons and initial fruit yields by 160 percent when young peach trees are grown in a killed-sod system compared to a herbicide-strip

system (Welker and Glenn, 1988). In these previous studies, no additional fertilizer had been added to the study areas.

In the present study, we wanted to determine whether growth differences were related to a soil fertility effect. We found that, after two years, the trees in the killed-sod treatment had a significantly greater wood weight than with the other treatments (Table 1). There was a small but significant fertilizer effect with no interaction between soil management system and fertilizer application level.

Soil organic matter levels were also significantly influenced by the soil management system (Table 2), with the killed-sod system having the highest level and the seeded grass the lowest. We had demonstrated previously that there was an interaction between the soil management system, soil organic matter level, and tree growth (Welker and Glenn, 1988).

In the present study, we used analysis of covariance to evaluate the effects of soil management treatment on tree growth at a constant level of soil organic matter (2.1 percent) (Table 3). These adjusted means are interpolations of what the treatment response would be at the mean level of soil organic matter (2.1 percent). The analysis of covariance again demonstrated a significant interaction between the soil management system and tree growth when soil organic matter was considered as a covariate. For the same level of soil organic matter the killed-sod system developed a larger tree than the cultivated, sod plowed, or seeded treatments when either fertilized or unfertilized. The basis for this interaction lies in the synergism between the interrelated soil parameters and the effectiveness with which the young peach tree utilizes the resources of its soil environment. Clearly the addition of fertilizers cannot bring about the level of tree growth attainable with the improved soil environment developed in a killed-sod system. In commercial production, young peach trees receive approximately 100 g $Ca(NO_3)_2$/tree/year in the first three years with a herbicide-strip system. We find that with a killed-sod no additional fertilization is required during this period to achieve even greater growth and yield than in the conventional herbicide-strip system.

The pool of soil organic matter is considered the primary factor controlling soil structure and nutrient availability in non-fertilized soils (Russell, 1971). The fact that significantly different growth responses can occur for the same level of soil organic matter indicates that these soil management systems have other limiting factors. We have shown that the killed-sod system reduces rainfall runoff and maintains a higher level of plant-available water than in the cultivated or herbicide-strip systems (Glenn and Welker, 1989). The increased level of plant-available water offers a partial explanation for the increased growth of trees in the killed-sod treatment.

The orchard production systems of the eastern U.S. are often established without the use of irrigation. Presumably irrigation and fertilization of young peach trees would cause equal or greater tree growth than with non-irrigated trees in a killed-sod system. However, the economics or availability of water often limit such a practice. The use of a killed-sod system will result in greater tree growth and increased fruit yield in young peach trees, a primary economic concern of orchardists. Equally important is the impact the killed-sod system has on the soil environment. We have shown that, compared to the conventional herbicide-strip system, the killed-sod system reduced fertilizer requirements, rainfall runoff potential, and the associated runoff of pesticides and fertilizer materials. The killed-sod system

Table 1. The effect of 4 soil management systems and fertilization on peach tree wood weight.

	Tree wood weight (kg/tree)				
Fertilization	Killed sod	Plowed sod	Seeded grass	Cultivated	Mean
+	43.0	36.3	22.8	25.3	31.9 a*
−	39.2	34.0	19.5	20.2	28.2 b
mean	41.1 a*	35.2 b	21.2 c	22.8 c	

* Mean within a row or column followed by the same letter do not differ significantly at $\alpha = 0.10$ using Duncan's Multiple Range Test.

Table 2. The effect of 4 soil management systems and fertilization on the level of soil organic matter.

	Soil organic matter (%)				
Fertilization	Killed sod	Plowed sod	Seeded grass	Cultivated	Mean
+	2.3	2.2	1.9	2.1	2.1 a*
−	2.3	2.2	1.9	2.1	2.1
mean	2.3 a*	2.2 a	1.9 b	2.1 ab	

* Means followed by the same letter do not differ significantly at $\alpha = 0.05$ using Duncan's Multiple Range Test.

Table 3. The effect of 4 soil management systems and fertilization on peach tree wood weight adjusted by analysis of covariance to a 2.1% level of soil organic matter.

	Adjusted tree wood weight (kg/tree)			
Fertilization	Killed sod	Plowed sod	Seeded grass	Cultivated
+	41.0 a*	34.8 bc	25.4 d	25.3 d
−	36.7 b	33.1 c	23.0 de	21.0 e

* Adjusted means followed by the same letter do not differ significantly at $\alpha = 0.05$.

also improved soil structure, and increased infiltration capacity and soil organic matter, which are of great importance in pesticide degradation by soil microbes.

We view the killed-sod management system as a program primarily for young trees. Young peach trees require a large vegetation-free area to maximize their early growth and yield (Welker and Glenn, 1985). The killed-sod system is a means to achieve this while minimizing the detrimental impact associated with the conventional herbicide-strip system. Once the peach tree has filled its allotted space in the orchard, a shallow-rooted, short-growing grass can be seeded beneath the trees, leaving only a narrow strip of bare soil. The sod will continue to protect the soil surface, reduce runoff, and further increase the soil organic matter level and microbial activity, thus increasing the potential for pesticide degradation. Tree yield is unaffected by the shallow-rooted sod because the peach root system is already established and can effectively compete with the sod for nutrients and water.

The orchard soil management system of the future will be very different from that which is commonly practiced today. The killed-sod management system and the establishment of a shallow-rooted, short-growing grass beneath mature trees is a viable alternative with strong environmental safeguards to the established systems currently utilized.

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Low-input, sustainable agriculture bills introduced in Senate

Two bills designed to eliminate conflict between federal farm commodity programs and sustainable agriculture practices have been introduced in the U.S. Senate. The Farm Conservation and Water Protection Act (S. 970) was introduced on May 11, 1989, by Senator Wyche Fowler of Georgia, Chairman of the Conservation and Forestry Subcommittee of the Senate Agriculture Committee. The bill would allow farmers using rotations to keep their "base acreage" allocations and would give modest incentives for farmers to move toward more sustainable practices. The incentives include credit, crop insurance, and low-input certification.

The bill calls for concerted efforts by the USDA to inform farmers of promising advances in low-input systems, conservation, integrated pest management, best management practices, and other less intensive methods which reduce reliance on dangerous chemicals without sacrificing production. It also calls for USDA to come up with recommendations for certifying foods produced without pesticides. In related sections, the bill calls for expanding the Conservation Reserve Program to 60 million acres and targeting restoration of one million acres of wetlands.

Responding to concerns about rural drinking water wells, the bill calls for testing of such wells to detect pesticides and nitrates. It also directs the Extension Service to help farmers develop low-input systems to protect ground water in areas found to have contamination. Addressing continued concern about conversion of prime farmlands to nonfarm uses, the bill asks USDA to report on those trends.

The second bill, the Conservation Enhancement and Improvement Act (S. 1063), introduced by Senator Richard Lugar of Indiana, is largely targeted at expanding the Conservation Reserve Program by expanding the time of contracts, encouraging the planting of hardwood trees, and including wetlands and areas with ground water contamination in the lands eligible for Reserve status. This bill also calls for elimination of federal farm program provisions that create obstacles to use of crop rotations.

Rather than define details, S. 1063 calls for "a sense of Congress" that base acreage requirements should provide greater flexibility to permit sound farming techniques, including rotations. In contrast to the Fowler bill, it does not provide for other incentives to help farmers make the transition to low-input agriculture. The Lugar bill also asks the U.S. Department of Agriculture, on request from states, to certify state programs that label foods as having been "naturally grown."

Understanding farm operator opposition to government regulation of agricultural chemicals and pharmaceuticals: The role of social class, objective interests, and ideology

Gilbert W. Gillespie Jr. and Frederick H. Buttel

Abstract. *This study seeks to identify the social factors related to opposition to government regulation of agricultural chemicals and pharmaceuticals. Analysis of data from a 1982 survey of farm operators in New York State shows that, in contrast to much of the literature that represents farmers as being almost universally opposed to regulation, farm operators' orientations toward government regulation of these substances vary considerably. Indicators of the class status or position of farm operators were found to be directly related to opposition to regulation. Willingness to assume risk and the importance placed by farm operators on making profit were also directly related to opposition to regulation, while farm men's off-farm work, cynicism toward agribusiness, non-economic orientation toward agriculture, perceptions of potential side effects of agricultural chemicals and drugs, and liberal political attitudes were inversely related to opposition to regulation. The results of a multivariate analysis suggest that farmer opposition to government regulation of agricultural chemicals is primarily due to farmer ideology and has little relationship with whether farmers actually use these chemicals.*

Key words: groundwater pollution, soil contaminants, health effects, feed additives, antibiotics, agribusiness, farm profits, farmer ideology, attitudes

Introduction

Despite widespread beliefs about the independence and freedom of farmers, it is well known that their activities are increasingly affected by forces external to agriculture. Among these external forces is the increased role of manufactured inputs in agricultural production (Cochrane, 1979; Friedland et al., 1980; OTA, 1986; Goodman et al., 1987). Between 1971 and 1976, for example, the quantity of pesticides used by farmers increased by 38 percent (Eichers et al., 1978). Of this total, herbicides constituted about 60 percent and increased by 76 percent during the period. With the exception of cotton production, these trends have continued through the early 1980s (Conservation Foundation, 1987). There has also been increased government regulation of agricultural activities and substances used in production.

The growing importance of regulation is of particular interest because many agricultural chemicals and pharmaceuticals are not only considered to provide benefits to the users but also may have harmful side effects not easily attributable to the particular chemical or pharmaceuticals involved (Kim and Stone, 1980; Russell, 1978). Such side effects may have long latency times, as is the case with cancer-causing substances (carcinogens), or may have only indirectly traceable effects, as in the case of PBB (Coyer and Schwerin, 1981). Furthermore, it is sometimes not the substances themselves but rather their metabolites (Lowry, 1974) which are toxic or carcinogenic.

In this paper, we begin by examining briefly the socioeconomic context of the regulation of agricultural chemicals and pharmaceuticals and reviewing the scanty literature on this topic. We then develop and test a theoretical framework for understanding farm operator opposition to government regulation of these substances. The principal purpose of the analysis will be to contribute to a better understanding by social scientists, policy makers, and regulatory agency personnel of the risk and regulatory preferences of farm operators.

Previous empirical research on farmers' attitudes toward regulation of agricultural chemicals

Despite the growing importance of government regulation of agricultural chemicals, surprisingly few studies of farmers' orientations toward these regulatory policies have been conducted. Most of these studies have been reported in the fugitive literature or have remained unpublished, and most have major methodological shortcomings that limit their generalizability. Moreover, most of this research has focused on determining the regulatory orientations of farmers as a whole and has given little

Gilbert W. Gillespie Jr. is Research Associate and Frederick H. Buttel is Professor, Department of Rural Sociology, Cornell University, Ithaca, NY 14853-7801.

attention to variations in farmers' orientations. Nonetheless, the results of several of these studies suggest hypotheses to be tested in a more comprehensive research design.

A previous study, one on Texas farm operators in heavily irrigated areas where groundwater depletion posed problems, showed that the severity of groundwater shortages was inversely related to farmer opposition to federal regulation of groundwater (Baird with Smith, 1976). Though this study was seriously flawed by a low response rate and other methodological problems, the conclusion that farm operators would be more accepting of federal regulation when faced with greater threats to their enterprises is of theoretical interest for this study because it suggests that material interests rather than ideology affect farm operator opposition to government regulation.

Another study of farmer attitudes toward government regulation focused on water pollution from agricultural activities in the Great Lakes basin (Powers and Jarecki, 1977). The purpose of this study was to determine what kinds of government regulatory approaches would be acceptable to farm operators. Nearly three-fourths of the respondents thought that voluntary cooperation of farmers was the best way to control water pollution from agricultural activities, though this belief was inversely correlated with the views that fertilizers, pesticides, manure, and eroded soil were sources of water pollution. The vast majority of the respondents did not connect the use of fertilizers and manure or the existence of soil erosion with pollution of the Great Lakes. This study suggests that understanding the objective consequences of practices would be related to acceptance of government regulation.

A study by Bernstein et al. (1976) of attitudes among corn and cotton producers corroborated the notion that farm operators tend to resist government regulation of substances used in agriculture; these authors reported that, when a pesticide was found to have negative health effects and was withdrawn from the market by government regulatory action, a common response among farm operators was to stockpile the banned pesticide for use during the coming years. Those farm operators who had the best sources of information on impending withdrawals and who had the resources to buy large quantities of the pesticide tended to stock up on it so that they had it available for up to three years after the pesticide was withdrawn from the market. The greatest concern of these farm operators seemed to be the economic effects of not having the pesticide (e.g., concern about increased cost of production, lower yields, and lower farm income). These farm operators seemed unconcerned about the health or environmental effects of the banned pesticide. Similarly, in a study of farmer pesticide use decisions and attitudes toward alternative crop protection methods done at a time of considerable adverse publicity about aldrin and dieldrin residues in milk, soybeans, and other produce, Von Rumker and Horay (1974) found that farm operator respondents seemed to see this primarily in economic terms, especially in relation to possible legal action against producers of products containing residues of these substances. The authors concluded that fear of punishment for marketing commodities with detectable residues would contribute the most toward compliance with pesticide bans.

Despite the above evidence of general farm operator antipathy toward government regulation and lack of concern about the non-economic side effects of agricultural chemicals, other studies indicate that farm operators would sometimes accept regulation. One study of a small sample of "early-innovating," corn-growing farmers from southern Wisconsin showed that farmers were ambivalent about pesticide regulations (Ross et al., 1967). On the one hand, about three-quarters of the sample agreed that the government should have the power to inspect agricultural commodities and condemn contaminated produce. On the other hand, nearly three-quarters of the respondents disagreed with the idea that farmers should be restricted in pesticide use. Over two-thirds disagreed with a statement that pesticide application should be restricted to licensed applicators and over one-half disagreed with a statement that the pesticide industry opposed restrictions so that more of their product could be sold.

The above studies raise some issues pertinent to the present paper. Depending on how questions were posed and their context in a study, findings about receptiveness toward government regulation could easily shift. This conclusion is further supported by an unpublished study conducted at Colorado State University (n.d.) which was discussed by Salcedo et al. (1971). Unfortunately, the report of this unpublished study is not available for examination, but Salcedo et al. claim that the study found that, while farm operators tended to favor use of pesticides and agricultural chemicals more than did home gardeners or even pesticide dealers, farmers ironically were also most likely to favor government regulation of pesticides and agricultural chemicals. On an abstract level, it would seem unlikely that a farm operator would want no government regulation of pesticides; few farm operators would be expected to favor measures permitting manufacturers of agricultural chemicals to sell any chemical that they had developed without government screening to ascertain safety and efficacy. We thus anticipate that a high percentage of farm operators would oppose a total absence of regulation because of the apparent conflict of their own interests with those of chemical and pharmaceutical manufacturers. On the other hand, if a survey question refers to studies or data involving substances with low-level, long-term risk to humans or to the many uncertainties of risk assessment involved with regulatory actions, we would then expect a greater tendency toward farm operator opposition to regulation. Indeed, some of the results of the studies discussed so far suggest that the respondents did not favor very tight restrictions on pesticide use and that they were not particularly concerned about latent side effects of the pesticides on their own health and that of others.

The Salcedo et al. (1971) study found that there was no great difference between rural and urban residents in their attitudes toward pesticides. Both groups tended to blame accidents on the users rather than on the companies which produced them, but some respondents were

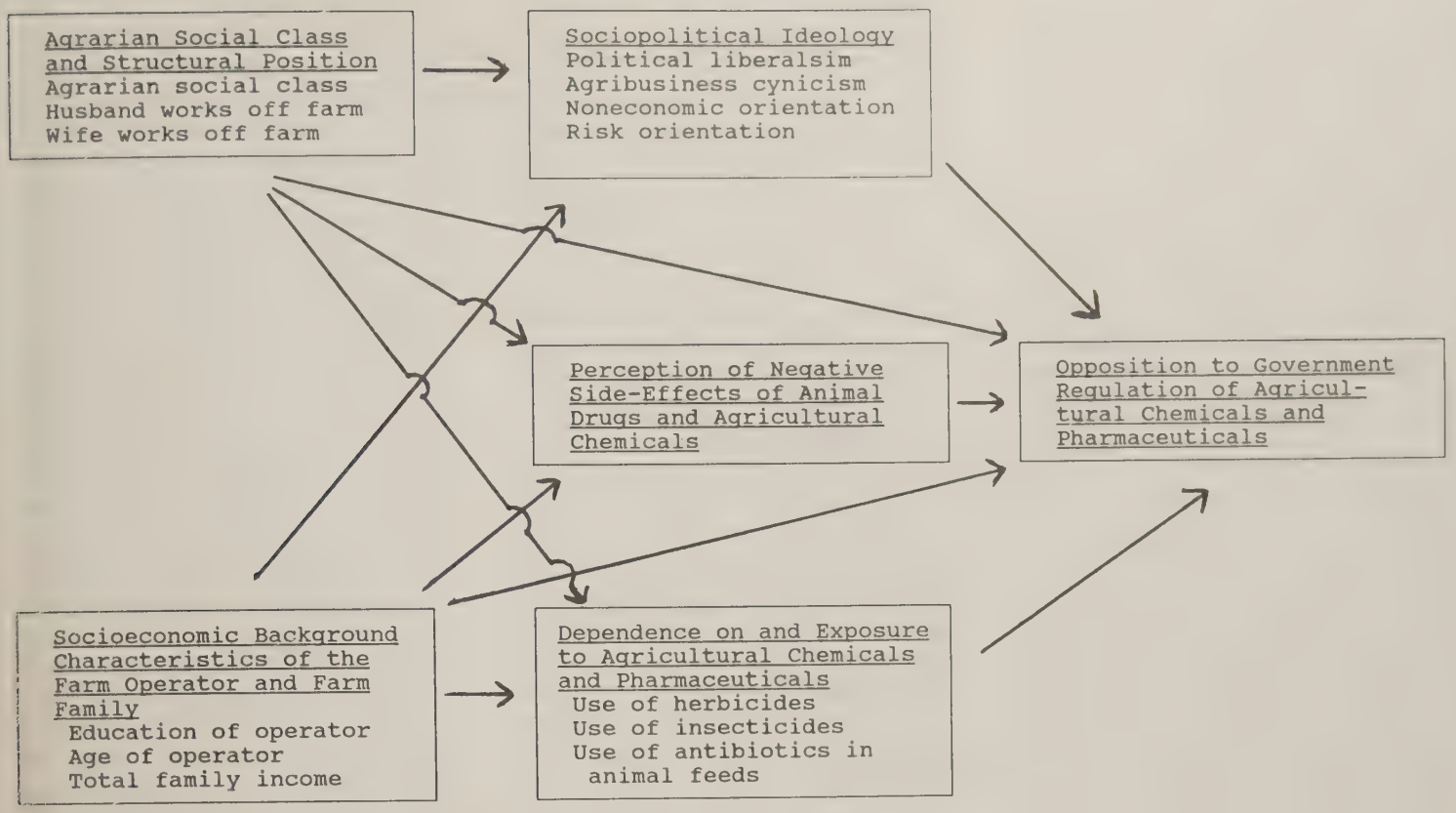
reported to have lingering suspicions that the pesticide industry deemphasized the hazards associated with its products. However, the extent of this could not be discerned from the article.

Finally, a more recent study by Hoiberg and Bultena (1981) showed that farm operators' attitudes toward government involvement in agriculture were not clear and consistent, a finding which they attributed in large part to differences between earlier and more recent types of government involvement in agriculture. After World War I, the federal government encouraged certain agricultural practices through subsidies and maintained agricultural commodity prices through various programs. These agricultural policies ostensibly promoted the interests of the producer clientele of the agencies involved (see also Hadwiger, 1978). In the 1960s and 1970s, however, a new type of regulation emerged in which the federal government began to restrict the use of agricultural chemicals and pharmaceuticals and certain agricultural practices to deal with the negative side effects of the emerging agricultural system. These newer regulatory programs differed from earlier programs in requiring compliance, rather than being voluntary and based on incentives. They also were aimed at protecting the public interest rather than improving the economic conditions of farm operators. In addition, they required certain agricultural practices and investments that farm operators were likely to have understood to be contrary to their economic interests. Thus, these programs would potentially be opposed by farm operators.

The Hoiberg-Bultena study is noteworthy in that it was the first to focus on variations in farmer orientations toward different types of government regulation. Hoiberg and Bultena found a great deal of variation in farm operators' views toward government involvement in different areas of regulation, a finding that they concluded to be the result of both the characteristics of the different types of government involvement and diversity in the situations of farm operators. Based on a factor analysis of responses to attitudinal items pertaining to government involvement in different aspects of agriculture, three dimensions of attitudes toward government intervention were identified. The *first factor* included attitudinal items relating to regulations involving feed additives and pesticides. These items generally pertained to programs about which few farm operators thought there was too little government control. The programs in this first category were both coercive and imposed constraints on the use of innovations that might have increased productivity when used in addition to currently used practices. The *second factor* consisted of attitudes toward government programs for soil conservation and land use. For the items comprising this factor, farm operators were much more likely to perceive that the amount of government control was too little and were less likely to perceive that it was too much than on the previous factor. The referents of these items tended to be voluntary programs which have favorable economic implications for the farm operators. The *third factor*, which included measures of attitudes toward regulation of agricultural safety and production, was more difficult to interpret, but, on these measures, few farmers thought that there was too little government involvement. On the item pertaining to agricultural safety, the majority thought that there was too much involvement, and on the item pertaining to agricultural production, half thought that the amount of involvement was about right. Hoiberg and Bultena concluded that it was necessary to distinguish particular areas or related combinations of areas of government regulation in agriculture, since farm operators seemed to have different attitudes toward different clusters of government programs. A further interesting finding of Hoiberg and Bultena was that relationships between attitudes toward government programs and several demographic and attitudinal variables were not consistent. They did, however, find that farm size was weakly but positively related to the perception that there was too much regulation of feed additives and pesticides (Hoiberg and Bultena, 1981, p. 389).

Development of hypotheses

Hoiberg and Bultena's work has two major implications for the present study. *First*, their results suggest that farm size would be positively related to opposition to regulation of agricultural substances such as pesticides and pharmaceuticals. *Second*, however, two other features of the Hoiberg-Bultena study imply a modification of the first implication within the context of New York State agriculture. One such feature is Hoiberg and Bultena's own observation that farmer orientations toward government regulation of agriculture apparently reflect a complex and differentiated pattern of ideology and immediate material interests. Another is that agricultural chemical use differs considerably between Iowa (the site of the Hoiberg-Bultena study) and New York State. In particular, we suspect that given the highly capital-intensive conditions of production in the fertile Corn Belt state of Iowa, use of agricultural chemicals such as herbicides and insecticides is virtually universal (Von Rumker and Horay, 1974), although the intensity and type of use would vary with differences in agroclimatic regions of the state. In contrast, New York is a state with a large number of small and part-time farm operators, with less expensive and lower-quality land, and with dairying as the predominant agricultural enterprise. Thus, agricultural chemicals are used less and hence farmers vary more in their use of or dependence on these chemicals. Our survey results indicate, for example, that gross farm income, a commonly used measure of farm size, bears a substantial positive relationship with use of insecticides ($r = .30$) and herbicides ($r = .40$). It would thus not be unlikely that, because of their material interests, operators of large New York State farms will express more opposition to government regulation of agricultural chemicals than will the operators of smaller farms. Moreover, given the tendency of operators of larger farms to be more politically conservative than operators of smaller farms (Buttel et al., 1982), we would have even more reason to expect that farm size would be positively related to opposition to agricultural chemica


Agrarian Social Class and Structural Position
Agrarian social class
Husband works off farm
Wife works off farm
Sociopolitical Ideology
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Agribusiness cynicism
Noneconomic orientation
Risk orientation
Perception of Negative Side-Effects of Animal Drugs and Agricultural Chemicals
Opposition to Government Regulation of Agricultural Chemicals and Pharmaceuticals
Socioeconomic Background Characteristics of the Farm Operator and Farm Family
Education of operator
Age of operator
Total family income
Dependence on and Exposure to Agricultural Chemicals and Pharmaceuticals
Use of herbicides
Use of insecticides
Use of antibiotics in animal feeds

Figure 1. Model of farmer opposition to government regulation of agricultural chemicals and pharmaceuticals.

regulation.

These considerations suggest a model for understanding farmer opposition to government regulation of agricultural chemicals and pharmaceuticals. Figure 1 indicates that two sets of variables - indicators of agrarian social class or stratum position, and indicators of other socioeconomic background characteristics - are treated as exogenous causal factors. These two sets of variables are conceptualized to affect three sets of endogenous, intervening variables: social and political ideology, belief in the potential of hazardous side effects from using agricultural chemicals, and use of (or exposure to) these chemicals and pharmaceuticals. Finally, the exogenous and endogenous variables are conceptualized to shape variations in farmer opposition to government regulation of agricultural chemicals and pharmaceuticals.

As indicated above, we hypothesize that indicators of agrarian social class, including measures of farm size and agricultural wealth (such as gross farm income, acres operated and farm assets), will be positively related to opposition to government regulation. At the same time, indicators of farm men's and farm women's off-farm work are hypothesized to be inversely related to opposition to government regulation, given that off-farm work might make the economic implications of regulation less salient. Education, by leading to an ability to better understand the complexity of the effects of agrochemicals, would be inversely associated with opposition to regulation of these substances. We also hypothesize that another indicator of socioeconomic background, age of operator, will be directly related to opposition to government regulation because older farm operators are expected to be less aware of the negative side effects of new agrochemicals as a result of having their ways of thinking established in a time of relatively few known hazards of this type. We also hypothesize that total family income, the final indicator of socioeconomic background characteristics, will be directly related to opposition to regulation of agrochemicals.

The central feature of the model in Figure 1 concerns the roles of farmer ideology and interests as intervening variables in explaining farmer opposition to regulation of agricultural chemicals. This study will employ several indicators of sociopolitical beliefs and ideologies as explanatory variables for understanding opposition to government regulation of agricultural chemicals and pharmaceuticals. Political liberalism, which we hypothesize to be inversely related to opposition to regulation of agricultural chemicals, will be used to gauge farmers' political positions on matters that are not specifically agricultural. We will also use four indicators of agriculturally related beliefs and ideologies. We hypothesize that both agribusiness cynicism (see Buttel et al., 1982) and non-economic orientation toward agriculture will be inversely related to opposition to government regulation

of chemicals and pharmaceuticals, while both profit orientation and risk orientation will be directly related to opposition.

A single-item attitudinal variable, belief in the possibility of hazardous side effects of use of agricultural chemicals, will be used to assess the degree to which knowledge of the possibility of these side effects shapes acceptance of or opposition to regulation. We hypothesize that belief in the possibility of hazardous side effects will be inversely related to opposition to government regulation of agricultural chemicals and pharmaceuticals.

Use of (and exposure to) agricultural chemicals and pharmaceuticals represents a final cluster of explanatory variables. Each of these variables has a dual character. On the one hand, if a farmer uses herbicides, insecticides, or animal drugs, this is presumably the result of an economic decision based on the belief that using these substances is profitable and, accordingly, restricting legal use of these substances would probably be resisted. However, using these chemicals and drugs also implies exposure to potentially hazardous effects - and presumably a certain interest in effective regulatory control so that unduly hazardous substances are not sold to farmers. We conjecture, however, that for most farmers these variables reflect dependence on the use of chemicals and pharmaceuticals, and hence are a source of opposition to their regulation.

Data and method

Data collection

Mail questionnaires were sent to a random sample of 1,000 farm operators in New York State in February, March, and April of 1982. The sample came from the list of farm operators held by the New York State Crop Reporting Service. A major purpose of the survey was to learn about issues pertaining to the use of antibiotics in animal feeds; to ensure adequate numbers of livestock producers for empirical analyses, hog and poultry producers were oversampled. The survey methodology was based on Dillman's (1978) "total design method", with those in the sample having been sent an 18-page questionnaire and a cover letter explaining the study in mid-February, and a follow-up postcard one week later. For those who had not yet responded within three weeks of the original mailing, a second copy of the questionnaire and a different cover letter were sent. Those who had not yet responded by seven weeks after the original mailing received a third copy of the questionnaire and a third cover letter by regular mail. Completed questionnaires were received from 644 farm operators. Correcting for those who were not farm operators, the response rate for the total sample was 68.8 percent (See Gillespie, 1987, Chapter 5 and Appendix C). For this paper, we weighted the cases in the hog and poultry producer subsamples by a factor of 0.3, leaving an effective sample of 456 farm operator respondents. This produced an effective response rate of 69.1 percent, correcting for those in the sample who were not farm operators.

Variables

Dependent variable. The dependent variable, *opposition to government regulation of agricultural chemicals and pharmaceuticals*, was measured with a four-item, Likert-type index which included items pertaining to the relative degree of desired government regulation, the locus of responsibility for screening substances for safety, the appropriateness of potential for harm as sufficient grounds for regulatory action, and relative importance of health effects and economic effects. Each of the items in this and all the other attitudinal indexes was scored from 1 to 5. After certain attitudinal items were reverse scored, as appropriate, the scores on all items were summed for each respondent and the total score was divided by the number of items. Thus, the range for each attitudinal index was 1 to 5. The operationalizations and summary statistics for the dependent variable and the other multiple-item attitudinal variables are presented in Appendix A.

Independent variables. The independent variables were grouped into five major categories as outlined in the model in Figure 1. The first category of independent variables pertained to the agrarian class and structural position of the farm operator and farm family. These included measures of agrarian social class, farm men's off-farm work, and farm women's off-farm work. The *agrarian social class* scale was computed from several measures of agricultural enterprise size and value of agricultural assets: gross farm income, net farm income, total value of farm assets, farm debt, total acres operated, and number of full-time hired workers. These items are presented in Appendix A. Because the metric of the variables comprising the scale was not uniform, the scale was constructed of standardized versions of the component variables. *Farm men's off-farm work* and *farm women's off-farm work* were measured by questions asking for whether either was employed off the farm for wages in 1981 and were scored as dummy variables.

The second category of independent variables consisted of general socioeconomic background characteristics and included the level of education and age of the farm operator and total family income. *Education* was measured by a question asking the respondent to indicate the highest level of education attained from a list of nine categories ranging from no formal education to a graduate degree. *Age* was also measured by an open-ended question and was scored as the exact number of years reported. *Total family income* was measured with an item with a set of response categories the same as those used for this variable in Census of Agriculture publications.

The third category of independent variables consisted of two subsets of indicators of sociopolitical ideology. The first subset was that of "general political attitudes," which included an index of *political liberalism*. The second subset of socoiopolitical attitudes involved measures of orientations related specifically to agriculture. These included indexes of: (1) *agribusiness cynicism* (which pertained to distrust of agribusiness and awareness of the vulnerability of farm operators which results from the activ-

ities of large-scale business), (2) *profit orientation* (which pertained to attitudes on the importance of making a profit from agricultural activities), (3) *non-economic orientation* (which measured views about the importance of non-monetary motivations for engaging in farming), and (4) *risk orientation* (which pertained to views on the acceptance of high levels of financial risk in farming). The operationalization and summary statistics for both subsets of political-ideological indicators are reported in Appendix A.

The fourth category of independent variables was, as noted earlier, a single-item indicator of attitudes about the *potential for adverse side effects from the use of agrochemicals*. The responses to the particular Likert-type item - "Some agricultural chemicals and drugs may have undesirable side effects that will not appear for 10, 20, or even 30 years into the future" - were scored from one to five, with high scores indicating agreement with the statement.

The final set of independent variables consisted of indicators of dependence on and exposure to agricultural chemicals and pharmaceuticals. *Use of herbicides* and *use of insecticides* were measured with direct questions and scored as dummy variables. The indicator for *use of antibiotics in animal feeds* was constructed from questions asking farm operators whether they used antibiotic additives in the feeds of particular kinds of animals. If a respondent reported that such additives were used in the feed of any of the animals on the list, the case was assigned a score of 1; otherwise a score of 0 was assigned.

Results

Given the emphasis of many previous studies on farmer opposition to government regulation of agricultural chemicals, referring to the descriptive statistics for the dependent variable in Appendix A is useful. Although the wording of items greatly affects the numerical scores for attitudinal indexes, the direction and magnitude of the deviation of an actual sample mean from the hypothetical midpoint can be cautiously employed to assess the overall pattern of attitudes or beliefs. The grand mean for the index of opposition to government regulation of agricultural chemicals and pharmaceuticals was 2.43, substantially below the hypothetical midpoint of 3. The index also had a relatively small standard deviation (.69), indicating that the majority of farmers either mildly favored some government regulation of agricultural chemicals and drugs or were ambivalent about it. Nonetheless, cases in the sample varied across the full range of scores (from the potential lower bound of 1.0 [no opposition] to 5.0 [strong opposition]). Our results, which indicate considerable diversity in farmers' orientations toward agrochemical regulation, are more consistent with Hoiberg and Bultena's (1981) findings than with those of earlier studies which stressed a strong tendency for farm operators to oppose regulation.

Table 1 reports the zero-order correlation coefficients for the relationships between the independent variables and the measure of farmer opposition to government regulation of agricultural chemicals and pharmaceuticals. These results are generally consistent with our hypotheses. The indicator of agrarian social class position is positively related to opposition to government regulation of agrochemicals, while the political ideology index and perception of potential adverse side effects of the use of agrochemicals are inversely related to opposition. The major departure from our expectations is that the indicators of direct material interests in the use of (and, correspondingly, exposure to) these substances had little relationship to opposition to government regulation of agricultural chemicals and pharmaceuticals; the only statistically significant zero-order correlation was a small one for use of insecticides.

The first hypothesis, that agrarian class position would be related to opposition to government regulation of agricultural chemicals and pharmaceuticals, is supported by the positive (though modest) correlation coefficients between the agrarian class scale and opposition to government regulation of agricultural chemicals and pharmaceuticals. The second hypothesis, that opposition to regulation would be directly related to the other measures of agrarian social class, is supported only for men's off-farm work. Contrary to our hypotheses, none of the indicators of socioeconomic background characteristics (education, age of the operator, total family income) was correlated with opposition to government regulation of

Table 1. Correlation and OLS regression analyses of antecedents of opposition to government regulation of agricultural chemicals and pharmaceuticals.

Independent variables	Zero-order correlation coefficients	Regression coefficients	
		b	Beta
Agrarian class	.182***	.004	.044
Man works off farm	−.141**	−.195*	−.109
Woman works off farm	.053	.187*	.110
Education of operator	.007	−.010	−.023
Age of operator	.020	.003	.056
Total family income	.075	.011	.023
Political liberalism	−.287***	−.180***	−.206
Agribusiness cynicism	−.158***	.012	.013
Profit orientation	.142**	.054	.075
Noneconomic orientation	−.171***	−.078	−.083
Risk orientation	.187***	.078	0.95
Perception of negative side-effects	−.275***	−.175***	−.201
Use of herbicides	.069	−.008	−.005
Use of insecticides	.096*	.075	.049
Use of antibiotics in animal feeds	.050	−.002	−.001
Constant		3.177***	
Adjusted R2		.160	
F		6.106***	

*p ≤ 05.
**p ≤ .01.
***p ≤ .001.

agrochemical substances.

The zero-order correlation coefficients in Table 1, however, indicate general support for the hypothesis of inverse relationships between liberal political ideology and opposition to government regulation of agrochemicals. The coefficients in Table 1 also indicate support for our hypotheses that indicators of agrarian sociopolitical ideology would be related to opposition to government regulation of agricultural chemicals and pharmaceuticals; agribusiness cynicism and non-economic orientation have statistically significant inverse bivariate relationships with opposition. Similarly, the data are consistent with the direct relationships hypothesized between the other indicators of agrarian sociopolitical ideology (profit orientation and risk orientation) and opposition to regulation of agrochemicals. The data in Table 1 provide support as well for the hypothesis that the perception of negative side effects of animal drugs and agricultural chemicals would be inversely related to opposition to agrochemical regulation.

The bivariate results suggest several tentative conclusions. Opposition to government regulation of agrochemicals tends to be associated with operating large farms, with farming full time, with denying the possibility of negative side effects from the use of these substances, and with conservative sociopolitical attitudes. Such opposition is related modestly to use of insecticides but not to use of herbicides and animal drugs. Put somewhat differently, farmers tend to form attitudes about government regulation of chemical substances used in agriculture based more on their *class position and especially their sociopolitical attitudes* than on the basis of *whether these substances are objectively important* in their particular farming operations.

Given the substantial relationships between opposition to regulation and several clusters of independent variables, we used multiple regression to assess the causal priority of these independent variables. Although Figure 1 would suggest path analysis, the number of variables involved would make presentation of results quite complicated. Thus, we present only the direct effects of the independent variables on opposition to regulation. The regression model fitted included all the independent variables postulated to affect opposition to regulation. The results for this analysis (Table 1) show that the best predictors of opposition to regulation are political liberalism and perception of potential negative side effects of agricultural chemicals and drugs. The partial slope coefficients for farm men's and women's off-farm work are also statistically significant. The coefficient for farm women's off-farm work is, however, the inverse of what we had hypothesized. These results reinforce the tentative conclusions that we articulated above, with two exceptions. First, agrarian social class seems to exhibit most of its influence indirectly (for example, through its inverse relationships with political liberalism and men's off-farm work and its positive relationship with women's off-farm work). Second, several of the ideological variables - agribusiness cynicism, profit orientation, non-economic orientation, and risk orientation - have little independent influence on opposition to regulation of agricultural chemicals and pharmaceuticals.

Discussion

While most previous studies have indicated that farmers tend to oppose government regulation of agrochemicals, our results suggest that the opinions of farm operators vary significantly on this score. Our data suggest that opposition to the regulation of agrochemical use bears little relation to whether or not farmers actually use these substances: opposition to regulation is, in substantial measure, a *phenomenon of farmer ideology, rather than merely of direct material interests in the use of particular chemicals or pharmaceuticals.* Moreover, our study suggests that agrarian social class is positively related to opposition to regulation of agrochemicals at the bivariate level not because farmers with larger farms have the greatest dependence on herbicides, insecticides, and animal drugs, but rather because such farmers tend to have conservative sociopolitical orientations. Despite being indirect, this link between agrarian social class and opposition to regulation of agricultural chemicals and pharmaceuticals is, however, still important as the material base for ideology.

Also noteworthy is that one of the principal correlates of opposition to government regulation of agrochemicals revealed in this study was the perception of negative side effects of the use of these substances. Perception of side effects was, however, measured only with a single-item attitudinal variable. More adequate, multi-item measurement of perception of side effects would very likely have increased the magnitude of its relationships with other variables. Nevertheless, the importance of farmers' views on the possible dangers of side effects of using agrochemicals indicates that, should conditions warrant, farmers' views about regulation of these chemicals could be substantially modified through educational programs about the adverse health consequences of particular substances. Such a strategy is particularly plausible given the fact that to the degree that American farmers express concern about the externalities of agricultural chemical usage, it is primarily due to health and safety motivations (rather than, for example, to concern about environmental quality (Padgitt, 1988). These educational programs, however, would have to contend with the deep and profound ideological roots of current farmer opposition to government regulation of agricultural chemical and animal drugs.

Finally, do these findings apply beyond the state in which the data were collected? On the one hand, and as was noted previously, New York State and the Northeast differ in many respects from many other states and regions in agroclimatic characteristics and in the traditional mix of commodities produced. In particular, the predominance of milk producers among farmers with livestock is likely to distinguish New York farmers from farmers in many other areas in the country in terms of the relationship between use of antibiotics in animal feeds and agrarian social class. Also, hay crops are important in the state, and herbicides are seldom important in forage production. Thus farmers in the state may be generally less dependent on agricultural chemical

and drugs than are farmers in many other states. On the other hand, agricultural chemicals and drugs are important in the state, and their regulation has economic and health implications similar to those in other states. Further, if ideological factors are as important as is indicated by this study, then the more general material bases (agrarian social class) of opposition to regulation, especially with respect to conservative-liberal political orientation, are likely to reproduce these results elsewhere.

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APPENDIX A: Operationalizations and Summary Statistics for Indices

Indices/Component Items	Alpha	$\bar{X}$	SD	Range	N
Opposition to Government Regulation of Agricultural Chemicals and Pharmaceuticals	.55	2.43	.69	1.0—5.0	439

"Which *one* of the following five statements *best* describes your opinion about how much the government should restrict the use of agricultural chemicals and drugs?

1. The government should restrict the use of any new substance until years of exhaustive tests show no evidence of possible harm to people.
2. The government should restrict the use of any substance which is suspected of being a potential cause of serious health problems based on results of testing at high levels with rats or other animals.
3. The government should restrict the use of any substance if a small number of people who have been exposed to that substance are found to have a serious health problem more frequently than do people who have not been exposed to the substance.
4. The government should *not* restrict the use of any substance *unless* quite a few of the people who were exposed to it develop a serious health problem, even though this problem might not show up for 20 years.
5. The government should *not* restrict the use of any substance for human health reasons."

"The government, rather than private industry, should be responsible for testing substances to make sure that they are safe before allowing them on the market."* (reverse scored)

"Merely having the *potential* to cause problems is *not* a sufficient reason for the government to restrict the use of pesticides or animal drugs."*

"In government decisions to regulate use of a substance, economic disruption (loss of investment, loss of profit opportunities, or loss of jobs) should a *more* important consideration than future health effects."*

Agrarian Social Class Scale	.82	6.18	7.31	−6.96—35.07	427

"In 1981, what was your approximate *gross farm* income? (Gross farm income is your total farm income before subtracting farm expenses. If you farm in a partnership or corporation, include *only* your share in your answer.)

1. $2,499 or less
2. $2,500 to $4,999
3. $5,000 to $9,999
4. $10,000 to $19,999
5. $20,000 to $39,999
6. $40,000 to $69,999
7. $70,000 to $99,999
8. $100,000 to $149,999
9. $150,000 to $199,999
10. $200,000 to $499,999
11. $500,000 or more"

"In 1981, what was your *net farm* income? (Net farm income is gross farm income minus farm expenses.)

1. Costs exceeded income
2. Broke even
3. $2,499 or less
4. $2,500 to $4,999
5. $5,000 to $9,999
6. $10,000 to $19,999
7. $20,000 to $49,999
8. $50,000 or more"

"At the end of 1981, what was the approximate total value of your *farm* assets? (Farm assets include farm land, buildings, machinery, livestock, grain, and other farm property. If you farm in a partnership or corporation, include *only* your share in your answer.)

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APPENDIX A (Continued)

Indices/Component Items	Alpha	$\bar{X}$	SD	Range	N
1. \$2,499 or less 2. \$2,500 to \$4,999 3. \$5,000 to \$9,999 4. \$10,000 to \$19,999 5. \$20,000 to \$39,999 6. \$40,000 to \$69,999 7. \$70,000 to \$99,999 8. \$100,000 to \$149,999 9. \$150,000 to \$199,999 10. \$200,000 to \$499,999 11. \$500,000 to \$999,999 12. \$1,000,000 or more "At the end of 1981, what was the approximate total debt on your farm assets? (If you farm in a partnership or corporation, include *only* your share.)" Same categories as the above item. "What is the *total acreage* of the land you operated in 1981, including all wasteland? (If you farm in a partnership or corporation, include only your share.) _____ Acres" "How many permanent or full-time hired workers did you employ on your farm in 1981? (A permanent or full-time hired worker is one who works 200 days or more on the farm during the year.) 1. None; 2. One; 3. Two; 4. Three; 5. Four or more"					
Political Liberalism "The profits of the big industries should be controlled by the federal government."* "There should be *less* governmental regulation of business."* (reverse scored) "The tax structure should be changed so that the burden falls *more* heavily on large corporations and persons with large incomes."*	.53	2.89	.82	1.0—5.0	438
Agribusiness Cynicism "Food processors and retail chains should *not* be allowed to own farm production operations such as cattle feedlots, dairy herds, and vegetable farms."* "Ownership of farms by large corporations and other nonfarm groups is a major threat to the survival of the family farm."* "Large supermarket chains tend to use their buying power to hold down farm prices."* "Most manufacturers of farm machinery and agricultural chemicals are making big profits at the expense of the farmer."* "Farm prices are largely determined by large processors and retailers."* "If the economic situation for farmers continues like it is now, in a few years the family farm will be replaced by large farms run by hired labor."*	.69	3.57	.73	1.0—5.0	449
Profit Orientation "For me, farming is strictly a business."* "The only real objective in farming is to make a profit."* "In deciding whether or not to try any new practice, a farmer's first consideration should be: 'is it profitable?' "*	.76	3.32	1.00	1.0—5.0	442

Appendix A—continued next page

APPENDIX A (Continued)

Indices/Component Items	Alpha	$\bar{X}$	SD	Range	N
Noneconomic Orientation	.55	3.24	.76	1.0—5.0	449
"The major goal of young farm families should be to stay out of debt."*					
"There are so many good things about farming that a person should be willing to get along on a lower income to keep these advantages."*					
"The best farmers do not necessarily make the highest profits."*					
"It is better to make a smaller profit each year than to attempt something where there is a chance of financial loss."*					
Risk Orientation	.55	2.68	.85	1.0—5.0	448
I regard myself as the kind of person who is willing to take a few more risks than the average farmer."*					
"I would rather take a chance on making a big profit than to be content with a smaller but more sure profit."*					

Likert-type item with response categories: "strongly disagree" (scored as 1), "mostly disagree" (scored as 2), "uncertain" (scored as 3), "mostly agree" (scored as 4), and "strongly agree" (scored as 5).

Tougher regulations on pesticide use favored by 74 percent of farmers

Tougher regulations on pesticides to protect groundwater are favored by 74 percent of Southern and Midwestern farmers surveyed in August, 1988, reports Rural Voice, a new public interest group headed by Vermont Senator Patrick Leahy.

Of the 270 farmers surveyed, 68 percent also wanted to expand the Conservation Reserve program to reduce pesticide use and protect groundwater. Rural Voice is a new group formed to increase public understanding of the problems of rural states and communities. For more information contact the group at 426 C Street, NE, Lower Level, Washington, DC 20002.

Appendix B. Zero-Order Correlation Coefficients for Independent Variables

	Variables	X1	X2	X3	X4	X5	X6	X7	X8
X1	Agrarian social class	—							
X2	Man works off farm	−.30***	—						
X3	Woman works off farm	−.15***	.31***	—					
X4	Education of operator	.08	.12**	.07	—				
X5	Age of operator	−.13**	−.07	−.03	−.34***	—			
X6	Total family income	.11*	.14**	.10*	.10*	.01	—		
X7	Political liberalism	−.25***	.12**	.06	−.14**	.10*	−.21***	—	
X8	Agribusiness cynicism	−.27***	.12**	.02	−.18***	.11**	−.05	.43	—
X9	Profit orientation	.05	−.09*	−.06	−.16***	.12**	−.02	−.08	−.08*
X10	Noneconomic orientation	−.23***	.01	.02	−.31***	.27***	−.03	.26***	.30***
X11	Risk orientation	.26***	−.01	.01	.14***	−.13**	.05	−.20***	−.05
X12	Perception of negative side-effects	−.09*	.10*	−.02	.05	−.01	−.01	.11*	.21***
X13	Use of herbicides	.28***	−.06	−.05	.07	−.13**	.01	−.07	−.20***
X14	Use of insecticides	.33***	.04	−.06	.10*	−.06	.06	−.10*	−.10*
X15	Use of antibiotics in animal feeds	.10*	−.05	.02	.11*	−.11*	−.02	−.12**	−.14**

Appendix B. (Continued)

	Variables	X9	X10	X11	X12	X13	X14	X15
X1	Agrarian social class							
X2	Man works off farm							
X3	Woman works off farm							
X4	Education of operator							
X5	Age of operator							
X6	Total family income							
X7	Political liberalism							
X8	Agribusiness cynicism							
X9	Profit orientation	—						
X10	Noneconomic orientation	.11*	—					
X11	Risk orientation	.09*	−.16***	—				
X12	Perception of negative side-effects	−.17***	.17***	−.11*	—			
X13	Use of herbicides	.09*	−.11*	−.05	−.11*	—		
X14	Use of insecticides	.03	−.20***	.12**	.00	.33***	—	
X15	Use of antibiotics in animal feeds	−.09*	−.18***	−.16***	−.01	.02	.03	—

*p < or = .05.
**p < or = .01.
***p < or = .001.

An analysis of the California market for organically grown produce

Jacques Franco

Abstract. *The market value for organically grown produce in California was estimated to be at least 54 to 68 million dollars at wholesale prices in 1987. This market is rapidly growing. A 41 percent increase in the value of organically grown produce was observed in 1987. When this analysis was completed in early 1988, it was estimated that the wholesale value of the market could exceed $300 million by 1992. A sample analysis of 1986-1987 price and volume for organically grown broccoli showed relatively steady prices and a volume increase of over 50 percent, indicating a similar growth in market demand. Prices for organically grown produce are significantly higher than for conventional produce; however, in spite of high weekly volume volatility, organic prices appear to be less volatile than prices for conventional produce. This paper proposes that the collection, reporting, and analysis of organic produce market data be continued and improved and that new sources of data be integrated to ensure continued availability of timely market information. Availability of more market information should increase efficiency and aid the development of the organic produce industry. The paper also proposes that overall trends in the organic produce industry be systematically monitored by Federal-State Market News and that the increased use of market information by organic growers, growers considering the transition, and other interested parties in the industry be promoted.*

Key words: conventional produce, organic produce, broccoli, price premiums, transition growers, wholesalers, market size

Introduction

Organically grown produce is a small but rapidly expanding industry. Published information and statistics about the industry are limited as a result of its small proportions. In a 1984 survey of California's organic farmers, low demand was rated the most important factor limiting the increase of production at that time (Baldwin and Carrol, 1984). Since 1984, however, demand has increased dramatically, especially since the present analysis was conducted in early 1988. Discussion with industry participants about their perception of the market reveals that there is now informal agreement among many of them that more competition and more market information in the organic marketplace will probably cause the quality of produce to improve, the supply to increase and stabilize and force at least some prices to come down.

The Organic Market News and Information Service (OMNIS) was started by a joint effort of the Committee for Sustainable Agriculture and California Certified Organic Farmers in late 1984 to provide market information on organically grown produce in California. The first report was published in September, 1985. In it, selected distributors have been providing weekly reports on volume, grower, and wholesale prices, and an indication of oversupply and undersupply for more than 100 organically grown commodities.

Although it has many shortcomings (discussed in the next section), the OMNIS project is the only systematic effort known to the author to provide market information on organically grown produce. Preliminary analysis of the data collected by OMNIS has shown that organically grown produce prices do not always move in concert with those of conventionally grown produce (Auburn, 1986). Moreover, surpluses and shortages have been reported in relatively close proximity, indicating much more localized markets than for conventionally grown produce.

The distribution system for organically grown produce has not been thoroughly described. The *1987 CAAP Directory of Organic Produce and Products* lists over 80 wholesalers/brokers handling organically grown produce. A high percentage of the volume is handled by 10 to 12 of these wholesalers, and most wholesalers are concentrated in Northern California.

The purpose of this study was to estimate the size of the market and to analyze and compare historical data for organically and conventionally grown produce in California. To achieve this, the OMNIS database was used as well as discussions with industry leaders. Some questions the study tried to shed light on included: Do price premiums insure buyers against price volatility? Are premiums changing? If so, in what direction? Are wholesaler margins changing? If such is the case, how can this be explained? Are supply/demand relationships for organic produce more stable than for the conventional market?

Jacques Franco is a former Graduate Student, Graduate School of Management, University of California, Davis, CA 95616.

Methods

The OMNIS information system

The OMNIS information system consists of two databases. The Primary database contains the contributing distributor's reports, and the Summary database contains the aggregated weekly reports by commodity. This database has fields for price ranges, high and low grower price, high and low wholesale price, Los Angeles terminal market comparable prices, and indications of over and undersupply. As of January, 1988, when the OMNIS database was consolidated, the Summary database consisted of 16,000 records and the Primary database contained at least 42,000 records. The data used for analysis cover a 28-month period from September, 1985, through December, 1987.

Data adjustments

Because the OMNIS information system was originally designed for weekly reporting and not for analysis, data retrieval required extensive prior preparation and adjustments. Adjustments were carried out to account for and bring to a common base transportation and brokerage expenses and to allow for comparisons with conventional produce data. A detailed account of the technical procedures appears on the final report submitted to the Steering Committee for Sustainable Agriculture (Franco, Goodman, and Katz, 1988).

Limitations of the OMNIS database

A detailed discussion of the factors affecting the accuracy and representativity of the OMNIS sampling methods are discussed in Auburn (1986). The results presented here should be interpreted with caution in light of shortcomings of the data pointed out by Auburn, such as:

Consistency across time. The consistency of the information has been affected across time because of changes in personnel and data collection protocols and because product descriptors are not standardized.

Changes in the number of wholesalers reporting. Variation in reporting frequency occurred among wholesalers that supplied the OMNIS data during the analysis period. An average of about ten wholesalers contributed to each issue of the OMNIS report.

Geographical distribution of reporting wholesalers. Many of the wholesalers that report to OMNIS are based in Northern California, underrepresenting the southern part of the state. Reports are provided to OMNIS on a voluntary basis, and the sponsors of OMNIS, which are based in Northern California, have been more successful in gaining the cooperation of northern wholesalers.

Discussions with industry participants

Discussions were conducted with growers, distributors, researchers, and other industry leaders to gain their perceptions about prices, price stability, supply, supply volatility, growth rates, and outlook for the market for organically grown produce.

Results

Estimates of the market value for organic produce

The total wholesale value of produce reported by OMNIS grew 41 percent from $5,413,000 in 1986 to $7,634,000 in 1987 (Table 1 and Figure 1). Vegetables showed the highest growth, 64 percent, and melons decreased by 33 percent.

After consulting with industry participants, it was estimated that OMNIS reported 40 percent to 50 percent of the volume sold through wholesale distrib-

Table 1. Value of Organically Grown crops reported by OMNIS (wholesale prices in dollars)

	1985 (4th qtr.)	1986	1987
Berries	$ 311	$ 64,412	$ 90,604
Citrus	$ 250,050	$1,075,925	$1,416,508
Fruits	$ 220,905	$1,305,424	$1,539,303
Melons	$ 17,806	$ 284,978	$ 188,436
Herbs	$ 6,996	$ 48,009	$ 62,805
Vegetables	$ 545,250	$2,634,465	$4,337,183
TOTAL	$ 1,041,318	$5,413,213	$7,634,839

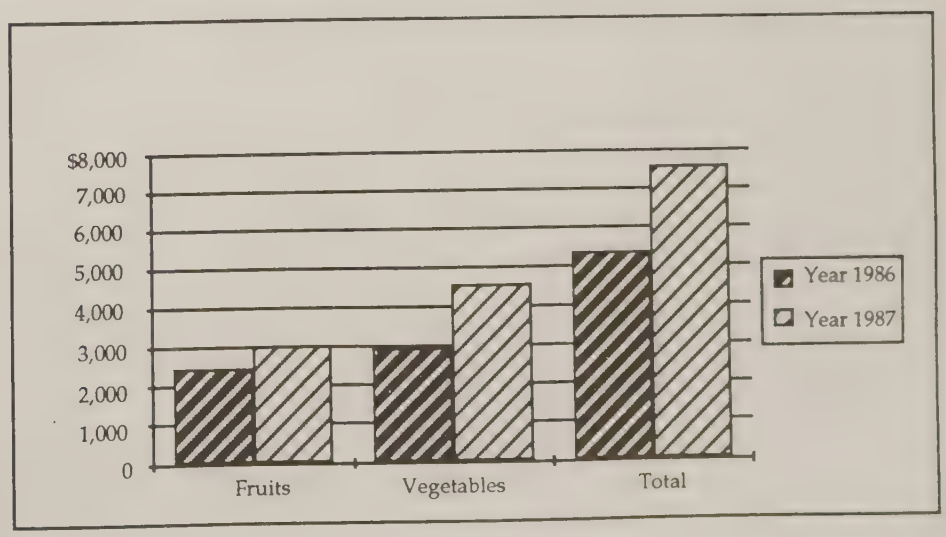

Figure 1. Organically grown produce reported by OMNIS (wholesale value in thousand dollars, California grown)

utors in California. Wholesale distributors' share of total sales was estimated to be 28 percent (Cook and Will, 1988). These figures imply that OMNIS reported only 11 percent to 14 percent of total organic produce sales. If true, the wholesale value of the market for organically grown produce would be approximately $54 to $69 million for year 1987. These figures are similar to California Certified Organic Farmers estimates and survey estimates by Cook and Will (1988), and less than 1 percent of the value of California grown fresh produce.

If current volume growth rates are sustained, the projected wholesale value of organically grown produce could exceed $300 million in 1992 (Table 2). These projections might prove to be conservative given that a number of leading distributors reported over 50 percent growth in sales. A recently conducted survey of consumer attitudes in three California counties showed that 24 percent of the persons interviewed look for organically grown food products regularly. This survey also indicated that 50 percent of the reporting individuals purchased some organic foods in the last three months (Jolly, 1988).

Broccoli: A sample analysis

Prices. Reported prices have remained relatively stable for the analysis period (Figure 2). This could indicate that consumption has grown in tandem with the more than 50 percent growth in supply; however, because of its small and immature nature, this market might not be subject to conventional forces of supply and demand. Prices for organically grown broccoli appear to be more stable than conventional broccoli prices. The relative low price variability is of special interest given the high weekly fluctuations in supply. This apparent stability in price has been reported by various industry sources and might be an added incentive for growers to produce organically. Bjornson (1988) analyzed the relationship between supply and wholesale price and found no statistically significant relationship from September, 1985, to May, 1987.

Average grower prices increased slightly from $11.20 a carton in 1986 to $11.28 in 1987. At the same time average wholesale prices increased from $14.30 a carton to $15 (Figure 3). Bjornson (1988) found the increased spread between wholesale and grower price statistically significant for most of the analysis period. This is an interesting finding in light of an intuitive expectation that increased marketing expenses would be absorbed by growers. Some

Table 2. Projected value of organically grown produce in California (wholesale prices in million dollars)

	Low Estimate*	High Estimate*
YEAR 86	$ 38.6	$ 49.2
YEAR 87	$ 54.5	$ 69.4
FORECAST 88	$ 68.1	$ 76.8
FORECAST 89	$ 85.2	$115.3
FORECAST 90	$106.5	$172.9
FORECAST 91	$133.	$259.4
FORECAST 92	$166.3	$389.

*low estimate assumes %25 yearly growth rate, high estimate %41

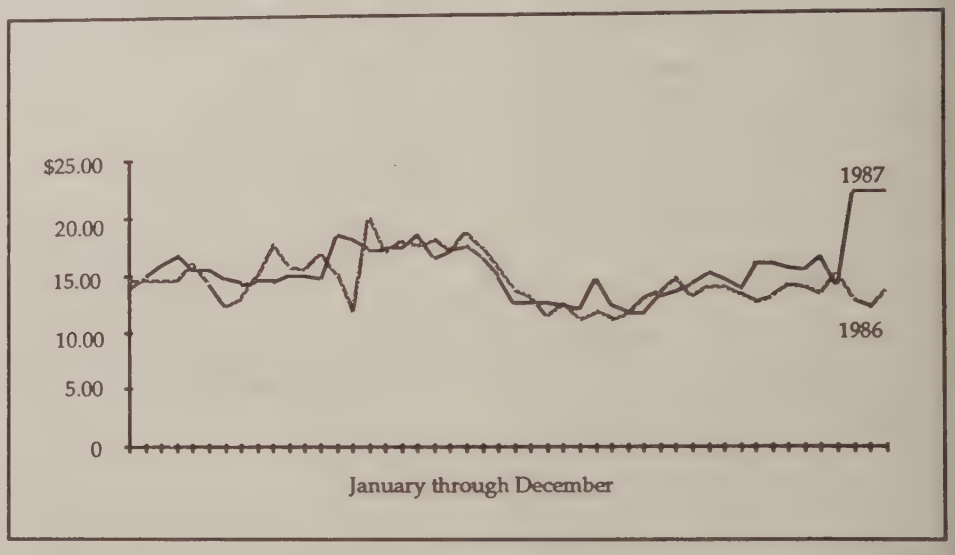

Figure 2. Comparative broccoli wholesale prices by OMNIS (California organically grown, 18-22 lb cartons)

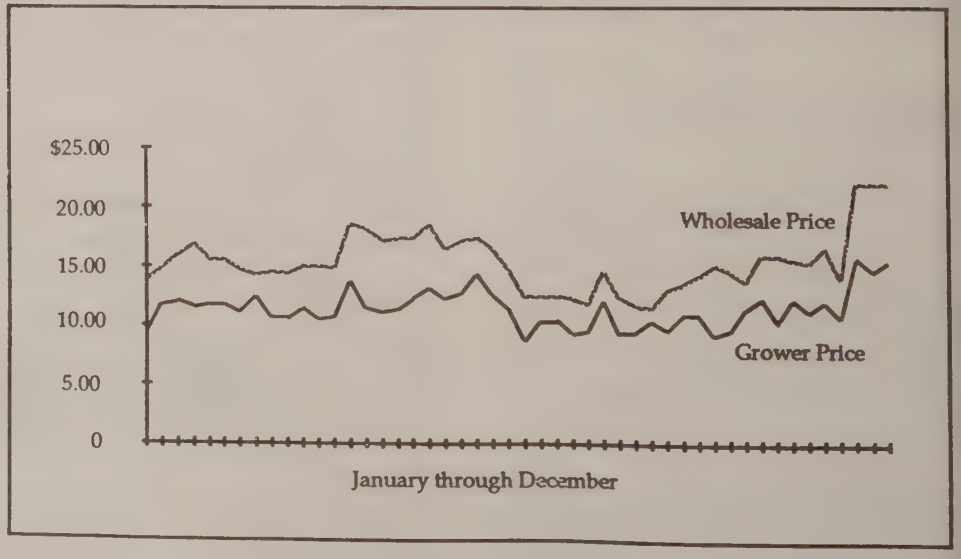

Figure 3. 1987 broccoli prices reported by OMNIS (California organically grown, 18-22 lb cartons)

possible explanations for increased wholesalers margins might be increased marketing costs, capital requirements for rapid expansion, or monopolistic rents.

Premiums received for organically grown broccoli are significant and have frequently exceeded 100 percent (Figure 4). Relative price stability may be related to these higher prices. Price premiums could be expected to decrease in the longer run if the present growth rates are to be sustained. Quality improvements are expected and have been reported by some wholesalers. These improvements might be due to increased grower experience and competition. Bjornson did not find any statistically significant changes in the organic and conventional price differentials for the period from September, 1985, to May, 1987.

Volume supplied. OMNIS reported during the 1986-87 analysis period a total of 50,381 18-22lb cartons of broccoli with a total wholesale value of $741,872 (Table 3 and Figure 5). This amount is a very small fraction of California's estimated $230 million broccoli production (1986 wholesale prices). The growth in volume from year 1986 to 1987 is slightly more than 50 percent. The weekly variation in reported volume is extremely high, from a low of 41 weekly cartons to a high of 1476 (Figure 6). Weekly supplies of conventionally grown broccoli do not fluctuate as much. The supply pattern is seasonal, with decreasing supplies during the warm periods of the year. Supply patterns for years 1986 and 1987 appear to be similar.

Over/undersupply indicators. Oversupply indicators for broccoli have been rarely reported by OMNIS for the analysis period; however, undersupply reports are quite common and appear to have a seasonal pattern (Figure 7). Bjornson (1988) tested the statistical significance of the undersupply reports and found that reported prices were generally higher ($0.895 per carton on the average) when undersupply was reported. This finding supports the validity of the reports since higher prices are expected during periods of undersupply. The oversupply indicators were not found to be statistically significant.

Analysis for additional crops is underway

1986-87 market data retrieved from the OMNIS Summary database for cauliflower, celery, and carrots is currently in various stages of analysis. Preliminary findings indicate some similar patterns to those observed in broccoli.

Table 3. Broccoli, Organically Grown (source: OMNIS Report)

YEAR	Reported Amt. (cartons)	Grower Price (average)	Whls. Price (average)	Value (whls.)
1986	19,776	$11.20	$14.30	$282,797
1987	30,605	11.28	15.00	459,075

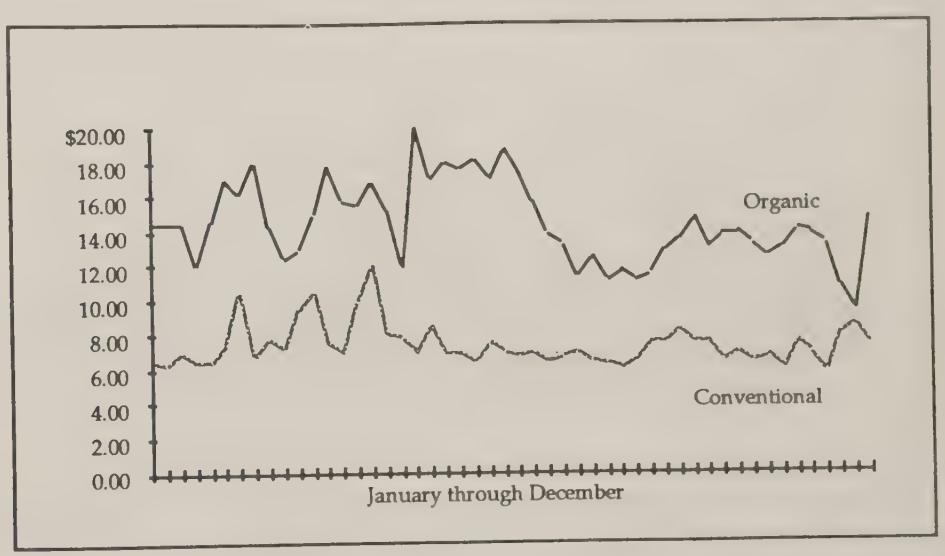

Figure 4. Comparative broccoli 1986 prices (in dollars per 18-22 lb cartons)

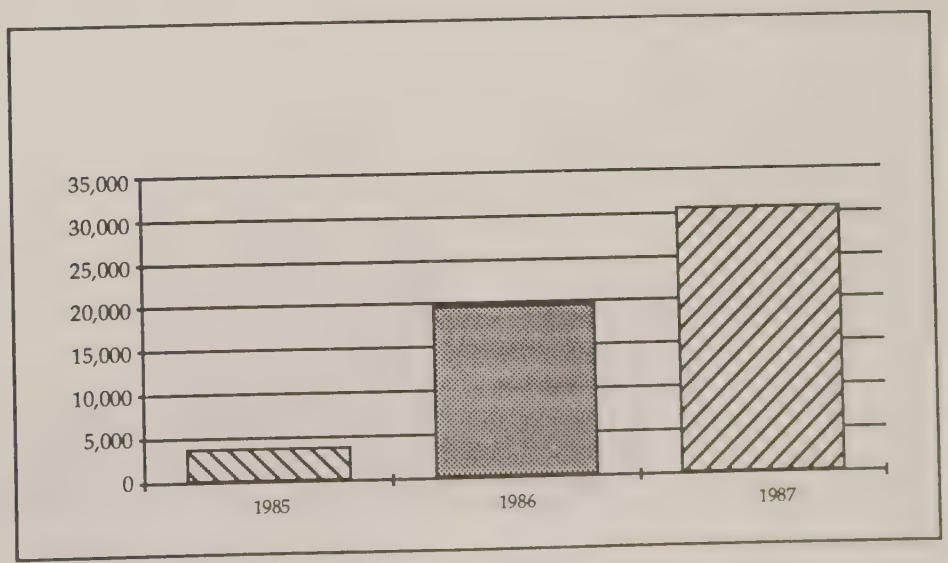

Figure 5. Broccoli supply reported by OMNIS (California organically grown, 1985 4th qtr., 18-22 lb cartons)

Trends and observations

Information gathered during the period of this analysis from distributors, growers, and other industry participants confirmed the author's perception of a highly localized market for organic produce. The organic produce distribution system is expected to become more integrated with the conventional distribution system as it grows and matures. Some industry participants have reported demand growth for some items. This is confirmed by the undersupply indications in some crops. Broccoli prices, however, did remain relatively stable during 1986-1987. On the other hand, some industry leaders perceived a well-supplied market with limited room for growth inside the "traditional" markets. Many of these individuals have pointed to the need for significant efforts to develop additional outlets. These conflicting views confirm perceptions of a disjointed market.

In the longer run, price differentials can be expected to decrease if current industry growth rates are to be sustained by increased penetration of organic produce into the conventional distribution system. This reduction in price differential can be attained by either decreasing organic produce price premiums or by increasing prices for conventional produce (or both processes occurring simultaneously). Lower prices for organically grown produce can be expected as the production practices are improved and as competition in the marketplace increases. Unit transportation costs for organics should also be expected to decrease as a result of economies of scale.

Improved organic produce quality has already been reported by some growers and distributors. Higher prices for conventional produce could result from additional costs of regulation on current production practices. Some indications of this process are already observable. For example, organic growers are lobbying to set lower worker compensation premiums, basing their claims on the fact that their workers are not exposed to toxic pesticides (Baker, 1988).

The demand for organically grown produce appears to be less elastic than the demand for conventional produce. This might be related to the fact that institutions such as restaurants are a larger part of the demand for organic

Figure 6. 1987 weekly broccoli supply as reported by OMNIS (California organically grown, 18-22 lb cartons)

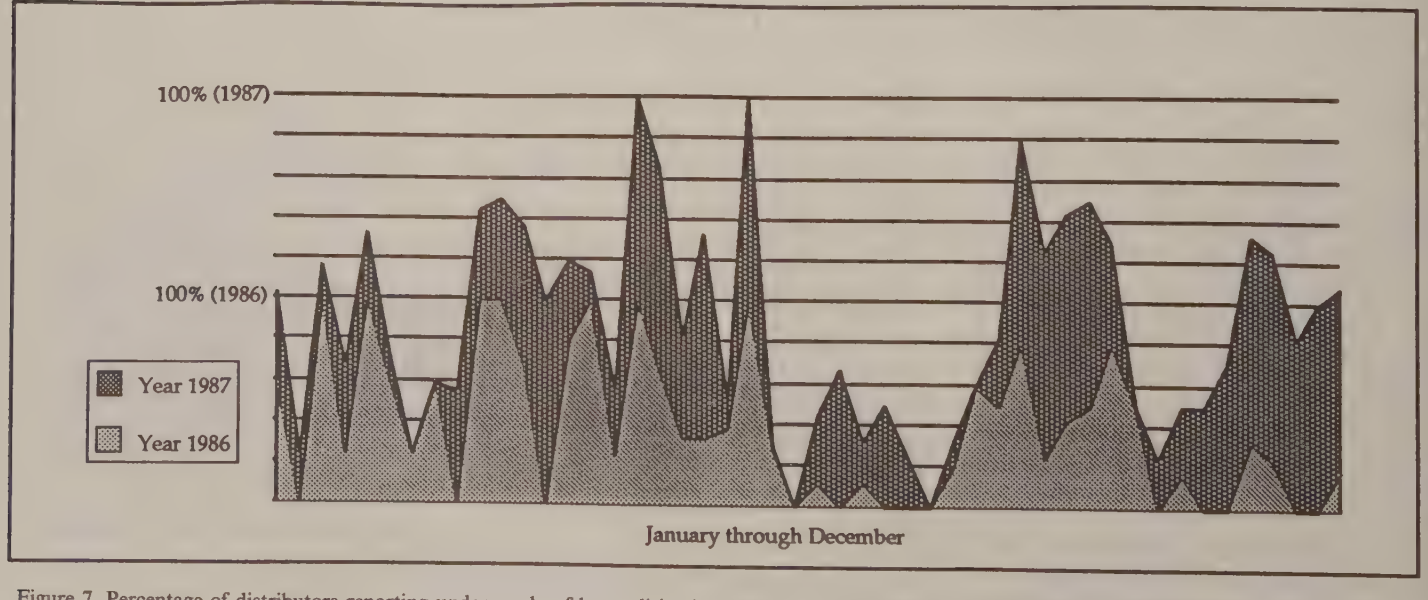

Figure 7. Percentage of distributors reporting undersupply of broccoli in the market (OMNIS report, California grown, organic)

produce than they are for conventional produce. It might also result from more stable grower/distributor relationships. There is contradicting evidence for the current status of supply and demand, although this can be explained in part by the fact that markets are localized. Relatively steady 1986-1987 prices, as in the case of broccoli data, could be indicative of equilibrium, but undersupply was reported more often than oversupply. Alternatively, price stability could be explained by the willingness of participants to maintain stable prices and create goodwill in a specialized, small, and immature market. There are a number of anecdotal reports that support this explanation.

A possible explanation for the more common reports of undersupply is that the OMNIS data is provided by wholesalers who might have a tendency to overstate undersupply (Auburn, 1986). It is extremely difficult to assess the supply/demand situation because of the very dynamic and localized nature of this high-growth market. The *Fresh Trends 1988* survey by "The Packer," which gives a profile of fresh produce consumers, reflects the contradictory messages: "They're a bit more adventurous in trying new items, somewhat skeptical of claims of brand superiority, keenly aware of the dietary contribution of fresh fruits and vegetables, not very interested in 'natural' produce and a little contradictory on the subject of pesticide residues."

To summarize, this work has documented some traits of the dynamic organic produce industry in California. The industry is in transition and is rapidly growing. Signs of a disjointed market are apparent as well as improvements in quality. Low volume and relative price stability have been documented for one crop, and possible explanations have been suggested.

Further analysis of price/volume behavior should be conducted. The OMNIS information system should be improved. Some of OMNIS' analysis and data collection functions could be taken over by Federal-State Market News. A survey of the distribution system for organically grown produce should be made. This baseline information, if made available to growers and distributors, could further aid market development.

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Iowa low-input projects demonstrate effective farm savings

In Butler County, Iowa, the Integrated Farm Management Demonstration Program is paying off for 50 farm families, report Iowa State University Extension leaders. As one example, they cite $15,000 in fertilizer costs saved by farmer Kevin Hummel in 1988 when soil fertility tests showed his land was high in phosphorus and potassium and did not require further fertilization in those two nutrients.

Soil sampling of all crop acres was completed for the 50 farms involved in the 1988 Butler County project. Field scouting was done weekly on those acres, and crop enterprise records with information on work in each field were started. Even where pesticides were used as a result of reports that spider mites were at high levels, the scouting allowed treatment to be concentrated on needed areas only. The project is supported in part by funds from the landmark Iowa Groundwater Protection Act.

Editor's Note. *The commentary section in this issue departs slightly from our customary practice in offering two articles on the same topic, both of which we have invited from two prominent agricultural economists well known for their work in alternative agriculture. Although the journal was founded primarily to present original research, we want to be sure not to ignore the more far-reaching concepts that give greater meaning to specific research results. The question addressed here is, no doubt, the most fundamental of all. Consequently, we feel it deserves a fuller treatment than it could get in a commentary by just a single author.*

What is alternative agriculture?

Pierre Crosson

Key words: pesticides, fertilizers, crop rotation, ecology, profitability, integrated pest management, yield loss

Alternative agriculture, sustainable agriculture, organic farming, regenerative agriculture, and low-input agriculture are terms that loosely denote both a philosophy of farming and a set of farming practices. Various statements of the philosophy can be found in the literature. The following by Harwood (1984) is representative:

Organic agriculture is seen by practitioners as a holistic endeavor, with attitudes and lifestyle of the farm family being inseparable from the well-being of the other components of the farm system. The all-important holistic nature of the farm implies interactions between components such as crops with crops, crops with animals, and soil condition and fertility with insect and disease incidence in the crops and livestock. These interactions, in the minds of many, limit the degree to which component parts may be meaningfully separated in field or laboratory studies.

The key feature of alternative agricultural systems, as stated by Harwood, is the interrelatedness of their various components. Indeed, this is what marks them as systems, rather than as loosely combined but essentially independent sets of farm operations.

The farming practices consistent with the philosophy of alternative agriculture vary in their details, but they have an important feature in common: They are designed to drastically reduce, preferably to eliminate, the chemical pesticides and inorganic fertilizers that are key elements of conventional agricultural systems in the United States. They do this by substituting crop rotations and cultivation for pest control, and manure, legumes in the rotation, crop residues, and other organic wastes for plant nutrient supply. The following definitions, taken from the literature of the last few years, illustrate these points.

An organic system is one which is structured to minimize the need for off-farm soil or plant-focused inputs. Because of lack of information on the disruptive effect of synthetic inputs, none are used. "Natural" sources of inputs are used with discretion. (Harwood, 1984)

Organic farming systems seek to significantly reduce, or to avoid entirely, the use of synthetic fertilizers, pesticides, growth regulators, and other agricultural chemicals. The system relies instead on crop rotations, crop residues, animal manures, legumes, green manures, organic wastes, cultivation, and non-chemical pest control to maintain the organic matter and tilth of the soil, to supply nutrients, and to control insects, weeds and diseases. (Papendick, 1984)

Alternative agriculture, as the term is used here, designates farming practices that avoid or at least minimize the use of non-renewable production inputs such as synthetically compounded fertilizers, pesticides and herbicides. (Anderson, 1985)

Organic systems, which make no use of externally supplied inorganic chemicals in the form of fertilizers, herbicides and insecticides, are a particular kind of regenerative agriculture. (Helmers et al., 1986)

Regenerative agriculture is characterized as a farming system in which an abundance of safe and nutritious food and fiber is produced using farming methods that are ecologically harmless, sustainable and profitable. Following a

Pierre Crosson is Senior Fellow, Resources for the Future, Washington, DC 20036.

transitional phase, chemical insecticides and other toxic compounds are replaced by reliance on natural biological controls to the maximum extent feasible. Renewable sources of soil nutrients are largely or totally substituted for chemical fertilizers. Methods of conservation tillage relying on routine applications of herbicides that find their way into water supplies or foodstuffs would not qualify as regenerative agriculture. Regenerative agriculture also incorporates profitability as part of the norm or goal; if farmers commit financial suicide in quest of ecological harmlessness, their form of agriculture is neither sustainable nor regenerative. (Madden, 1987a)

To achieve those objectives [of sustainable systems] these farmers employ a variety of alternative production and management practices and methods designed to maximize the use of on-farm resources such as animal manures and legumes to provide plant nutrients; crop residues, cover crops, and conservation tillage to control soil erosion and runoff; crop rotations to control weeds, insects and diseases; and energy conserving tillage systems to save energy and reduce operation costs. By the same token, they seek to minimize their dependence on costly off-farm resources such as chemical pesticides and fertilizers. (Parr et al., 1988)

The definitions by Harwood (1984), Anderson (1985), Helmers et al. (1986), and Madden (1987a) do not specifically mention the key roles of crop rotations and organic materials in alternative agricultural systems. However, Harwood clearly has these in mind in stating that organic systems substitute natural inputs for synthetic inputs, as does Madden in his reference to substitution of "natural biological controls" for "chemical insecticides and other toxic compounds" and "renewable sources of soil nutrients" for chemical fertilizers. And in their comparison of organic with conventional systems, Helmers et al. (1986) specified a rotation for the organic systems that included oats/sweet clover. These systems used no herbicides or inorganic fertilizer.

Must it be profitable?

Madden's (1987a) definition includes profitability to the farmer as one of the characteristics of alternative systems on the grounds that unprofitable systems will not be adopted, or if adopted will soon be abandoned. This, of course, is unarguable in any private enterprise economy. However, profitability does not set alternative agricultural systems apart from the conventional system. The latter also must be profitable or farmers will abandon it for some "alternative" system that is profitable. The fact that most farmers in the United States have not done this is *prima facie* evidence that under prevailing economic and policy conditions the conventional system is generally more profitable than any alternative. I have more to say about this below.

Is it conservation tillage?

Some writers, e.g., Parr et al. (1988) in the definition above, include conservation tillage as a form of alternative agriculture. This appears inconsistent, however, with the emphasis in alternative systems on reduced use of chemical pesticides and inorganic fertilizers. Many forms of conservation tillage, especially no-till systems, require more herbicides than the conventional system, and they do not generally require less insecticides or inorganic fertilizer (Crosson, Hawthorn, and Duffy, 1986). Madden's definition of alternative agriculture (1987a) quoted above is ambiguous about conservation tillage systems. If the systems rely on "routine applications of herbicides that find their way into water supplies or foodstuffs," then they do not qualify as alternative agriculture. But apart from the fact that the systems also rely on insecticides and fertilizers, this way of incorporating conservation tillage into the definition of alternative agriculture raises questions. Imagine two farmers, each employing the same form of conservation tillage and each with farming systems in all other respects identical except that the soils of one are sandy and those of the other are not. Suppose further that some of the herbicides applied by the farmer with sandy soils get into ground water and that those applied by the other do not. Is one of the farmers engaged in alternative agriculture while the other is not? To answer "yes" is to imply that alternative agriculture is not defined by a philosophy and a system of practices consistent with it but by the environmental consequences of a practice or set of practices. Indeed, by this definition, identical sets of practices may qualify as alternative agriculture under one set of circumstances and not under another, as in the example above. In fact, wherever conventional agriculture is practiced so as to prevent harm to the environment, it would qualify as alternative agriculture. A definition that implies such contradictory results is of dubious usefulness.

Is it improved fertilizer management?

If a practice described in the pages of this journal thereby qualifies as alternative agriculture, Madden is not alone in suggesting that any practice which bestows an environmental benefit is alternative agriculture. For example, Papendick, Elliot, and Power (1987) consider various procedures for improving the efficiency of crop use of nitrogen fertilizer to reduce the escape of nitrogen to ground and surface waters. One set of procedures is clearly a system of alternative agriculture consistent with the various definitions given above. But other procedures include improved soil testing for nitrogen content, applying fertilizer close to the time of maximum vegetative growth, use of nitrification inhibitors, and other techniques to reduce fertilizer applications. If successful and widely applied, these procedures clearly have potential for environmental improvement. Does that make them alternative agriculture? Farmers engaged in continuous cropping of corn and using the full complement of insecticides and herbicides, with no animals on the farm, might adopt the more efficient fertilization practices described by Papendick, Elliot, and Power (1987). If this would qualify them as "alternative farmers," what has happened to the philosophy of alternative agriculture as a holistic system aimed at drastically reducing, preferably eliminating, the use of all

inorganic materials and using mixed crop-animal cropping systems in rotation to do it?

Is it IPM?

Integrated pest management (IPM) also offers promise of environmental improvement, and articles about it have appeared in this journal. Does that qualify it as alternative agriculture? Bird (1987) quotes from a 1979 federal government report that defined IPM as:

A systems approach to reduce pest damage to tolerable levels through a variety of techniques, including predators and parasites, genetically resistant hosts, natural environmental modifications and, when necessary and appropriate, chemical pesticides.

In the United States, the greatest use of IPM has been in cotton production in Texas to control insect pests. The system used corresponds well enough to the definition just given. However, Texas cotton farmers using the system also use inorganic fertilizers and herbicides as needed, do not necessarily include livestock in their operations, and do not necessarily include a soil restoring crop in their rotation with cotton. Those farmers have reduced the burden of insecticides in the environment, but they have not adopted the philosophy of alternative agriculture and, except for IPM to manage insects, their practices are inconsistent with it.

Conservation tillage, improved fertilizer management, IPM, and any other practices that farmers have adopted and that bestow environmental benefits are, of course, to be applauded and encouraged. However, indiscriminately to call these techniques "alternative agriculture" when they are combined with others that are inconsistent with both the philosophy and practice of that system is not useful for either analysis or policy. I believe that the philosophy of alternative agriculture and the practices that embody it have much promise for the welfare of American agriculture and the American people. The key questions are what are the main obstacles to full realization of that promise and how might they be removed? To address those questions fruitfully, we need a coherent concept of alternative agriculture that not only specifies its main features but also indicates what sets it apart from the conventional system. Calling any environmentally beneficial practice alternative agriculture, even though it is combined with otherwise conventional practices, is to make an otherwise coherent concept of alternative agriculture incoherent.

Barriers to adoption

Insufficient profit

Farmers, like the rest of us, make decisions about how to manage their resources largely according to the relative profitability of the alternatives, as Madden (1987a) emphasizes. That alternative agriculture, as specified in the definitions above, has not been adopted by most American farmers indicates that most of them perceive it to be less profitable than the conventional system. The operative word here is "most." The statement does not deny that some farmers have found alternative agriculture just as profitable, maybe more profitable, than the conventional system. Nor does the statement deny that some farmers may be willing to accept smaller profits with the alternative system because of the high value they place on its environmental benefits. But most farmers are in neither of these categories. Otherwise, alternative agriculture would have been much more widely adopted. Indeed, it might now be the conventional system.

The main obstacle to the widespread adoption of alternative agriculture, therefore, is that most farmers perceive it to be not profitable, or insufficiently profitable, under prevailing economic, technical, and policy conditions. The key analytical problem is to explain this, and the key policy problem is how to make the system sufficiently profitable so that farmers will adopt it on a wide scale.

Commodity programs

One of the arguments regarding why alternative agriculture has not been more widely adopted is that federal government commodity price support programs discriminate against the system. Farmers participating in these programs have a certain amount of their cropland designated as "base acreage" for production of program crops. The larger a farmer's base acreage, the larger are the payments received when market prices of program crops fall below target prices, which has been most of the time in the 1980s. Farmers adopting alternative agriculture necessarily shift some of their cropland from program crops to a rotational system including a legume or some other soil restoring use. That land can no longer be counted as part of the farmer's base acreage. A farmer who adopts alternative agriculture under these conditions thus sacrifices income in the form of government "deficiency" payments.

The importance of this barrier to wider adoption of alternative agriculture is uncertain. John Lee, Administrator of the USDA's Economic Research Service, gave it major importance at the Institute for Alternative Agriculture's 1989 annual symposium in Washington, DC, in February, 1989.

Yield loss

Whatever the strength of the policy barrier, there clearly are others as well. In a survey of the literature on alternative agriculture covering the period from the mid-1970s to the late 1980s, Crosson and Ekey (1988) identified several factors that tend to make alternative agriculture generally less attractive to most farmers than the conventional system. One of these was a yield loss generally suffered by alternative agriculture. There were two sources to the yield loss. One was that in alternative agricultural systems some land each year is in a relatively low value rotation crop as part of the pest control and soil building features of the systems. Thus, even if the per acre yield of cash crops on land in those crops is as high as with the conventional system, the total production of those crops is less.

The other main source of the yield penalty is the difficulty of managing weeds without herbicides. The organic farmers studied by Lockeretz et al. (1984) reported that weeds were one of

their major problems. Fawcett (1983) notes that herbicides give better control of weeds in the crop row than cultivation. This permits higher seeding densities, thus higher crop yields. The literature review by Crosson and Ekey (1988) indicated that alternative agriculture farmers generally have lower outlays for purchased inputs. Typically, however, this is not enough to offset the yield penalty, so the system generally is not as profitable as the conventional system (James, 1983; Helmers et al., 1986; Dabbert and Madden, 1986).

Management requirements

Crosson and Ekey (1988) also found that alternative agriculture demands more management time and skill than conventional agriculture. In a discussion of some of the key characteristics of successful organic farmers, Madden (1987b) asserted that they are "superb managers" with complete knowledge of their farm operations. This is easy to believe. The greatly reduced reliance on, or elimination of, inorganic fertilizers and pesticides means that the farmer must understand the complex relationships among crops, weeds, insects, diseases, and soil fertility well enough to suppress threats to the crop and encourage the factors that make the crop thrive. To manage pest and nutrient problems, conventional farmers need much less understanding of these relationships. Organic farmers must also be more careful about timing field operations to achieve proper control of weeds (Fawcett, 1983). It is plausible also that they must devote more time annually to management than do conventional farmers.

The more demanding management requirements of alternative agriculture may be a barrier to its more widespread adoption. Acquiring new, complex management skills takes time, and farmers' time is scarce. Time spent in acquiring managerial skills and applying them on the farm is time not available for other purposes. Many farmers work off the farm. For them more on-farm work has an opportunity cost measured by lost off-farm income. More on-farm work also means less time available for recreation, family life, and other pursuits of value to the farmer. Given the generally unfavorable economic returns to alternative agriculture, it should not be surprising if many farmers decline to invest the time to acquire and use the skills needed to manage the system effectively.

Realizing the promise of alternative agriculture

If American society is to capture the environmental benefits of alternative agriculture, policies must be adopted that increase the attractiveness of the system for the rank and file of American farmers. Removal of policy biases against the system, such as the base acreage feature of commodity price support programs, would help. But this would not remove the other barriers that now stand in the way of wider adoption of alternative agricultural systems. More research on ways to manage weeds with reduced reliance on herbicides deserves high priority. Research is not likely to lessen the high managerial requirements of alternative agriculture. As long as farmers have the alternative of using inorganic fertilizer and pesticides under something like existing prices and regulations, the managerial requirements of alternative agriculture are likely to remain an important obstacle to its replacing the system that now is considered conventional.

Epilogue

The difficulties in overcoming the obstacles to widespread adoption of alternative agriculture may explain the readiness of some to redefine the system as any practice that bestows a net environmental benefit compared with the conventional system. Such practices have merit, but taken piecemeal they do not constitute an alternative system based on a coherent philosophy of farming. They cannot, therefore, be called alternative agriculture by the definitions given earlier. Perhaps the piecemeal approach offers the most promise for environmental improvement. If so, that is the path we should take. But let us call it by its true name, not alternative agriculture.

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What is alternative agriculture?

J. Patrick Madden

Key words: agchemicals, pesticides, water quality, health concerns, environment, low input, sustainability, grapes

Alternative agriculture is a goal and a movement. Like every goal, alternative agriculture is rooted in value judgments. By their very nature, value judgments vary from person to person; they change slowly in good times, but they shift more abruptly in response to crises. The values that gave rise to the alternative agriculture movement include alarm over human health risk from exposure to agricultural chemicals in air, water, and foods; abhorrence of environmental degradation, severe soil erosion, and depletion of natural resources; concern over the future of the family farm; and a desire to protect the rights of future generations to an abundance of food, clean water, and a decent environment. Values such as these have motivated many farmers, scientists, educators, and public officials to find better alternatives for agriculture. The quest is to improve the options that will enable more farmers to make a profitable transition from chemical-intensive methods to farming systems that are safer and more sustainable for present and future generations.

How can the goal of alternative agriculture be operationalized? Better alternatives? Better than what? Better by whose standards? When?

First things first. The term "alternative" has never been an ideal word to describe the goal and the movement to which it has been attached. I'm convinced there is no term that would be universally acceptable. Many fruitless hours of debate have failed to come up with a term that satisfies everyone. My personal preference is "regenerative." But this term engenders heavy resistance, especially from those who hold strong prejudices against anything associated with Rodale Press. Therefore, I have chosen to avoid its use in most public contexts. Other terms that have been suggested are "reduced input" (proposed by Fred Buttel), "lower input" (by Clive Edwards), and "sustainable," a term used to identify several state programs and centers.

The U.S. Congress used the term "low-input" in its 1988 appropriation bill allocating $3.9 million for the Agriculture Productivity Research subtitle (Subtitle C) of the 1985 Food Security Act. Because those who depend on federal appropriations for their livelihood prefer not to offend Congress, the term "low-input" has been widely accepted. Subsequently, a group of scientists and administrators at Washington State University, led by Dennis Oldenstadt, proposed the term "low-input/sustainable agriculture," in part because of its convenient acronym, LISA. This name has been attached to the Agriculture Productivity Research grants program, which I helped to organize and currently help to manage.

During the past decade, and especially since 1986, I have devoted a major portion of my professional time to a study of alternative agriculture, although not always under that term. Over the years, I have given scores of talks on this subject to small and large audiences, and I've had private conversations with countless individual scientists and educators in public and private organizations across the U.S. Until recently it was very common for scientists to scoff at the idea of doing research on alternative agriculture. These scientists, apparently suffering from the chronic condition known as "hardening of the categories," argued that a prerequisite for doing research is a once-and-for-all taxonomy of farming methods. They insisted on permanent labels that unambiguously distinguish alternative from conventional farming practices. They seemed to believe such a dichotomy is essential before scientifically valid experiments and statistical tests can compare the efficacy of chemical-intensive conventional and alternative methods of farming.

Often these scientists have scoffed at the hypothesis that the alternatives could be as productive or as profitable as conventional methods. Their standard for evaluating farming methods typically is maximum crop yield per harvested acre or maximum milk production per cow. Upon questioning them, I have found that they generally had never observed a commercial-scale farm that used alternative methods.

Other scientists, especially those who have observed or read credible accounts of successes in alternative agriculture,

J. Patrick Madden is Manager of Field Operations for the Federal Low-Input/Sustainable Agriculture (LISA) Program, Liaison between LISA and EPA, and Head of Madden Associates, a private consulting firm in Glendale, CA.

have transcended this rigid kind of thinking. They have operationalized the concept of alternative agriculture (by whatever name) in terms of specific practices and systems, in ways that have permitted rigorous research. Many articles in refereed journals such as the *American Journal of Alternative Agriculture* and *Biological Agriculture and Horticulture* illustrate that it can be done. Since January, 1988, when the LISA program was established, over 400 project proposals have been submitted by agricultural scientists and educators. Roughly one in seven of the proposals has been selected by regional technical committees for funding.

Operationalization of alternative or low-input agriculture into a research project design is not always easy. For example, one proposal that was not supported contained an otherwise excellent experimental design intended to compare conventionally managed plots with "low-input" plots. The error in the design was that the so-called low-input plots were to be managed exactly like the conventional plots, except that the chemical pesticides and fertilizers were withheld. This proposed "low-input" treatment could be more accurately characterized as benign neglect. A valid representation of low-input methods, as practiced by successful farmers and as included in LISA projects that were funded, features substitution of enhanced management and scientific knowledge for some (not necessarily all) chemical inputs.

The study by Hendrix et al. (1989) illustrates an effective way of operationalizing alternative agriculture in a research design. His experiments at two experimental farms in Georgia include one conventional and two alternative methods of controlling fungus disease in peaches, one called organic, the other called low-input. To ensure that the study included a valid representation of the organic treatment, it was designed in consultation with the Georgia Organic Growers Association. The conventional treatment consisted of spraying the entire orchard with a synthetic chemical fungicide. Plots under the low-input option were sprayed in alternate rows rather than every row. Brown rot fungus disease was controlled equally well with all three treatments at both locations. The treatments differed somewhat in how well they controlled insect pests. At one location, curculio and catfacing damage was 2 to 5 percent higher under the organic compared to the conventional treatment, while the low-input treatment (spraying alternate rows) was slightly more effective than conventional spraying.

The goal of alternative agriculture encompasses a wide range of farming practices and many areas of science. It includes, for example, integrated pest management programs that seek to minimize pesticide use by enhancing beneficial species and relying on crop rotations and pest resistant cultivars. It includes biological controls. It includes special methods of applying reduced amounts of chemicals, such as banding herbicide and avoidance of unnecessary fertilizer or pesticide applications. Inclusion or exclusion of specific practices are judgment calls. I prefer to focus on the goal and not get tangled up in minutiae.

But is it profitable?

As an economist, I have been startled year after year at how many people, including many scientists and educators, are offended when this question is asked. I have encountered many environmental advocates who have argued forcefully that money and profit should not enter into consideration in a farmer's choice of methods of production. If there is a more ecologically harmless and safer way, so the advocates say, farmers should simply do it without regard for mere monetary gain or loss. The "real profit," so the argument continues, should be counted not in terms of current income of a farmer, but in the immeasurable value of the health and well-being of future generations and the sanctity of the environment.

But farmers, like other people, must make a living, pay their bills, educate their children, and save for retirement. The rest of society has no right to expect farmers to take a vow of poverty just so present and future generations of consumers can have plenty of cheap but safe food. A realistic position is that society should invest in research and educational efforts that will lead to better alternatives. It is a truism that unless a farmer makes an acceptable return from farming, the business will eventually fail, whether or not alternative farming methods are used. Farmers urgently need methods of production that will provide a decent living while protecting the environment, human health, and the rights of future generations.

While this challenge is not easily met, a substantial number of successful examples have been documented. For example, the forthcoming report by the National Academy of Sciences, *Alternative Agriculture*, contains a dozen case studies of farmers who have successfully developed or adopted alternative farming systems.

One of these is Steven Pavich and Sons, with grape vineyards and other crops in central California and Arizona. The Paviches have pioneered in the development of alternative methods on their 2,200 acres of grapes. Their major source of fertilizer is 8,000 tons of composted steer manure per year, purchased from a local supplier. They have not sprayed any of their vineyards with synthetic chemical pesticide since 1986; that year a newly purchased vineyard in transition was sprayed once. Their major pest control strategy is to maintain a ground cover of native weeds, grasses, and legumes between the rows. This ground cover, which periodically is flail chopped, provides a habitat and food source for natural enemies of most pests.

When I first visited the Pavich ranch in 1982, they were producing about 0.8 percent of the total U.S. output of fresh table grapes. Since then, their market share has tripled; and they now produce over 30 million pounds of fresh table grapes a year. In 1982 the Paviches sold only about 3 percent of their grapes through "organic" outlets. They charged a premium for these grapes to cover the added cost of certification, special packing, and separate storage. The other 97 percent of the grapes were sold at regular market prices through major food chains in every state of the U.S. plus a dozen foreign countries. Because of the rapidly rising demand for foods

certified as pesticide-free, the Paviches expect to sell about 40 percent of their grapes as "organic" in 1989. These grapes are packed under the Pavich brand name, meaning they are certified as "organically grown" and have been certified as pesticide-free based on gas chromatography tests conducted under the direction of an independent firm.

The Pavich ranch is, of course, not typical. It is extraordinary in its size and financial success. But it is by no means unique in earning a substantial profit while using alternative production methods. Many other successful cases have been documented, starting with the seminal study by Lockeretz et al. (1981), and including more recent work by Cavigelli and Kois (1988) and Kirschenmann (1988). Clearly, alternative farming methods can be economically comparable or even superior to conventional methods of farming. They can, of course, also fail. The goal of research and educational efforts in alternative agriculture is to reduce the risk of failure and to enhance the profitability of farming methods and systems that are successively less dependent on synthetic chemical pesticides. Ultimately we seek to encourage development and adoption of methods and systems of farming that will provide an abundance of food at reasonable prices, without endangering human life or despoiling the environment, for generations to come.

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Call for papers

The **American Journal of Alternative Agriculture (AJAA)** invites submissions for a special issue devoted to the consequences of alternative systems beyond the farm gate. "Alternative" means any production system that in comparison to conventional practices is particularly concerned with environmental protection, resource conservation, food safety, and sustainability. Papers may deal with implications of alternative systems at any level from local to international. Examples include:

- Demographic, economic and social consequences for rural communities.
- Consequences for manufacturers and suppliers of farm inputs.
- Effects on agricultural structure (e.g., farm size, specialization, and land tenure) and the relative roles of capital, labor, and management.
- Interactions with federal and state programs.
- Appropriate strategies for research, teaching, and extension.
- Implications for U.S. agricultural trade.

Papers may report original research or present a carefully developed, well-supported analysis of a policy issue.

Deadline for receipt of manuscripts is December 1, 1989. Papers accepted after external review will be published in the **AJAA** in Volume 5 (1990). Submissions should follow the regular guidelines for **AJAA** manuscripts found on the inside back cover of every issue. We welcome informal inquiries about the suitability of particular topics.

For further information, contact Dr. Garth Youngberg, Editor, at the Institute for Alternative Agriculture, 9200 Edmonston Road, Suite 117, Greenbelt, Maryland 20770 (AC-301/441-8777).

Low-input rotations in North Carolina

Results from a few of the 1988 USDA LISA projects are reported in an April 20 memo from the Low-Input/Sustainable Agriculture Program office. Included is a summary of the crop rotation study carried out by Larry King at North Carolina State University. Because King had started the work in 1986, his project was underway when LISA funding allowed him to expand work to include testing allelopathic weed control and other alternative methods.

King compared conventional pesticide-based rotations with low-input, non-pesticide rotations. Conventional plots were no-till production with heavy reliance on herbicides. Low-input methods relied on crop rotations and mechanical cultivation for weed control and on legumes for nitrogen. In the three-year period, although corn yields in the low-input plots were lower than those of conventional (pesticide-based) crop rotations, they were higher than conventionally produced continuous corn and net returns were higher in the low-input plots.

Because of drought and heavy Johnson grass infestations, almost all of the plots registered net financial losses, but the conventional plots registered much higher losses. Conventional corn incurred a net loss of $171 per acre compared with a net loss of $95 in the low-input plots. The most dramatic contrast was in soybeans during 1986, when the net return from the conventional plot averaged a loss of $26 per acre, compared with a profit of $47 per acre under low-input management.

The Moore dairy farm

Susan Gage and Stewart Smith

Austin and Linda Moore have operated a small dairy farm in North Whitfield, Maine, since 1970. For the first ten years, they used conventional methods, which required buying large quantities of grain concentrates. Because of the high cost of feeds and the decreasing price received for milk, the family experienced the same economic crunch faced by many dairy farmers around the country. Traditionally, the way to increase returns under these conditions has been to increase milk production by expanding the herd. Presented with the choice of getting bigger or getting out, the Moores chose instead to implement an alternative system called Voisin Grazing Management, also known as intensive rotational grazing. This system is a comprehensive program to improve and maintain pastures and to use them more efficiently, with both economic and environmental benefits.

Feed is a major expense in milk production - in some cases accounting for as much as 65 percent of total costs. Reducing this expense is, therefore, an important way to make a dairy enterprise more profitable. Providing a herd with high-quality, highly productive pasture using the Voisin system is an economic way to do this, particularly if the forage can meet a substantial proportion of the herd's protein requirement. The Moore farm illustrates the successful implementation of this alternative system.

Susan Gage is a doctoral student and Stewart Smith is Henry Luce Professor of Agriculture and Society, School of Nutrition, Tufts University, Medford, MA 02155.

The farm's land and management

The Moore farm has 180 acres, of which 100 are in hay and about 28 are in permanent pasture fenced into 21 paddocks. The remainder is woodland. The hay land receives a low application of commercial N fertilizer, but no N is applied to the paddocks. Soils on the hay land are heavy - a mixture of morain-type clay, silt loam, and clay loam. The pasture soils are lighter but rocky. The terrain of the pastures varies widely, including some higher, drier knolls and low-lying land that was swampy before the Moores drained it. The farm buildings are centrally located; they are all on the same side of the road as the hay land, surrounded by it on three sides. The paddocks are directly across the road.

The Moores purchased their farm in 1970 and within two years built up their herd from 10 milkers to 35 milkers and 25 heifers. During the first 10 years, the farm used a conventional continuous grazing system in three or four open pastures. (During the period that this paper describes, the cows were Holsteins. However, when the Moores decided to switch to a spring calving schedule in November, 1988, they used the opportunity to replace the Holsteins by Jerseys because of their higher milkfat and protein levels.) Cows were put out to graze in mid to late May, and by August hay was needed to supplement the pasture, which had usually dried up and stopped producing by then. Grain concentrate, all of which was purchased, was used year-round as a feed supplement; this was a significant input even during the summer grazing months. From 1978 to 1980, the average yearly grain consumption per cow was 7,600 lbs. Hay was also fed year-round, except in June and July, the two heavy grazing months. The hay was cut on the farm and on 20 acres of rented hay fields.

In mid-summer 1981, Austin Moore happened to hear a lecture-slideshow by a New Zealand farmer about intensive rotational grazing. This system, which is based on the writings of the French scientist and farmer Andre Voisin, is used in several European countries and New Zealand. Austin Moore was so impressed by the presentation that the following day he bought the electrical charger necessary for the paddock fencing.

Voisin Grazing Management: General principles

In Voisin Grazing Management, pasture land is divided into small, permanent paddocks or lots, each surrounded by electric fencing and accessed by a gate. Water is piped to each paddock, and a water tank with a float is rotated from paddock to paddock with the herd.

The area of a paddock is chosen to be large enough for a specified number of animals to graze the pasture completely to a height of 2 to 3 inches within the "period of occupation" - ideally less than 2 days. The animals are then rotated to the next paddock, enabling the paddock just grazed to grow to 4 to 8 inches during a rest period. The rotation continues until all paddocks have been grazed, at which point the cycle is started over. Bill Murphy, an agrono-

mist from the University of Vermont who specializes in pasture management, recommends paddocks smaller than 2 acres for cattle.

Because forage production in the paddocks varies with weather and time of year, the rotation schedule requires continual adjustments, including longer periods of grazing, mowing, or the addition of temporary paddocks to the cycle. Management of the system involves three factors: 1) timely rotation of the herd while consistently monitoring the growth rates and condition of the forage; 2) clipping the plants every 2 or 3 cycles or when necessary, particularly in an especially rainy or long season; 3) maintaining and improving the pastures. The latter includes encouraging the growth of legumes, especially white clover, which thrives with close grazing. Also, some maintenance of the fencing is required.

Intensive rotation grazing may be used with almost any type of grazing animal. In the United States, the system is not widely known and has been used by only a small proportion of farmers, mainly with sheep. For dairy herds, it has resulted in milk production equal to or higher than former levels, while significantly reducing consumption of grain concentrates because the pasture is of higher quality and is used more efficiently.

Voisin Grazing Management at the Moore farm

The Moores' first step in converting to the Voisin system was to set up some experimental paddocks. They put the fencing up themselves, using locust posts cut on the farm, some reused and some new wire, and a fence charger, which they bought new. The next spring they installed more paddocks and the necessary water system, which consisted of low-cost plastic piping and faucets in all the paddocks, a moveable water tank, and a float. Start-up cash expenses were approximately $1,000 in the first year, $300 of which was for the New Zealand fence charger. By the summer of 1982, they had fully converted to the Voisin system, with 21 paddocks, each slightly over one acre and equipped with a water hook-up and a gate onto the central drive that connects all the paddocks.

The Moores' herd is in the field as early as April 23rd for daytime grazing; twenty-four-hour grazing usually begins around May 1st. With conventional grazing, the usual turnout date in their region is the middle of May or later. The early start allows the Moores' herd to keep up with rapid spring growth in the paddocks, which results in a saving because hay supplements are stopped early and feeding of grain concentrates is reduced. The herd is kept in each paddock for about 24 hours.

Under the Voisin system, the pasture keeps growing longer than under conventional management, so grazing can continue into the fall. The Moores bring their cows in for the night sometime around October 1st. Day grazing may continue until October 15th or later, depending on the weather. Total grazing time per year is thus increased. While no hay and a reduced grain supplement are fed during the summer months, grazing is supplemented in September and October with some hay and grain concentrate because less forage is available.

Inputs and milk production: The two systems compared

Consumption of grain concentrate has dropped steadily since the Moores began using the Voisin system (see Table 1). In 1982, the year of complete conversion to rotational grazing, grain consumption averaged 5,200 lbs per cow, a significant decrease compared to the conventional system (7,600 lbs during the period 1978 to 1980). This downward trend has continued: In the period 1984 to 1986, average annual consumption per cow was 3,970 lbs, or 48 percent below the 1978 to 1980 level.

The shift to greater dependence on high-quality forage and away from grain concentrate has not substantially lowered milk production or milkfat level. Production per cow initially dropped slightly for a few years from an average of 17,593 lbs under the conventional system (1978 to 1980). From 1984 to 1986, production was 4.5 percent lower than from 1978 to 1980, but the gap has been narrowing. Recent records show that the average milk production per cow was over 18,000 lbs in 1987. Even at its lowest level (1984), production was still 4 percent above the Breed Yearly Herd Average of 16,372 lbs per cow given in the Dairy Herd Improvement Association report from Cornell. Percent milkfat has remained stable. Between 1984 and 1986 it averaged 3.63 percent, compared with an average of 3.57 percent for 1978 through 1980.

The effect of the Voisin system on the Moores' dairy operation is most clearly illustrated by comparing the ratio of milk produced to grain consumed under the two grazing systems. From 1978 through 1980, the average was 236 lbs of milk per hundredweight of grain. From 1984 through 1986, after rotational grazing was in practice, the figure rose to 432 lbs per hundredweight, an increase of 83 percent. Consequently, the cost of producing milk is much lower under the Voisin system.

Table 1. Milk Production and Grain Consumption Per Cow

	Continuous and Rotational Grazing Systems Compared, 1977–1986			
	Year	Milk (lbs)	Milkfat (%)	Grain (lbs)
Continuous	1977	16,783	3.6	6,800
	1978	17,502	3.6	7,000
	1979	18,272	3.6	8,000
	1980	18,086	3.5	7,800
Transition	1981	17,600	3.5	6,600
	1982	17,067	3.5	5,200
Rotational	1983	16,973	3.4	5,200
	1984	16,735	3.6	4,500
	1985	17,334	3.7	3,900
	1986	17,352	3.6	3,500

Clearly Voisin Grazing Management works for the Moores, significantly reducing their cash costs. Installing the system required substantially less capital than would have been needed to increase net income a comparable amount by the usual strategy of expanding the herd. It also required a moderate amount of additional labor (supplied by the Moores) to design and install the paddocks. Managing the system substitutes the Moores' labor for purchased feeds without imposing significant cash costs.

Austin Moore believes that intensive rotational grazing has had important environmental benefits as well. Not only does it use an important resource and investment - their land - more efficiently, but it also has improved soil quality and the diversity of plant species. This bodes well for the sustainability of this grazing method. Comparably intensive use with conventional methods would probably have degraded the land.

Who can use the Voisin Grazing Management System?

Voisin Grazing Management requires closer supervision than continuous grazing. Successful management depends on frequent observation of the permanent pasture. Austin Moore inspects his paddocks daily; according to Henry Swayze, an electric fence dealer in Tunbridge, Vermont, successful New Zealand farmers walk their entire paddock loop at least once per week. The system also requires a willingness to be flexible, a solid understanding of the principles of rotational grazing, and active maintenance and improvement of the mix of plant species and the quality of the soil.

Because of the extra time commitment, not every dairy farmer will find the Voisin system attractive. However, for those who would willingly invest their own labor in return for reducing input purchases, rotational grazing is an alternative to expanding the farm or losing it and can enable a farmer to develop and sustain a high-quality pasture. The necessary skills could be learned by most people.

Although Voisin Grazing Management has proven highly successful for the Moores, it could not be employed indiscriminately with similar results. A farmer's consistent presence on the farm and ready access to the paddocks is probably necessary for success; a farm owner or manager who is frequently absent or delegates much of the work might get poorer results. In such a case, success would require a highly qualified hired supervisor. Similarly, rotational grazing might also be difficult on a large, complex farming operation whose manager is involved in many different activities besides dairying.

The size of the herd does not appear to be a constraint in moving the cows between the paddocks and the milking barn. Murphy points out that New Zealand farms with herds of 300 to 700 milking cows use the Voisin system with no difficulty, and there are Vermont farms that use it successfully with herds of 70 to 100 milkers. Especially in large herds, cows should be selected for ease of milking.

One potential constraint is the limited productive capacity of some pastures because of poor soils, topography, or climate. Some farmers might find that the nutrient quality of their paddock forage is not adequate to maintain high milk production levels without a protein supplement. Selection of cows that do well on pasture can help in this regard. Even so, this system may not be appropriate for a farmer whose primary goal is to maintain extremely high production per cow.

Conclusion

In this paper we describe a farm family who found a way to remain in dairy farming without expanding, by improving and using efficiently an important natural resource. Voisin Grazing Management allowed the Moores to increase the profits from milk production by substituting their own labor and management skills for purchased inputs. The capital requirements for implementing the system were very low.

Despite the demonstrated potential of rotational grazing to increase the returns of many farms significantly and to increase the efficiency of pasture feeding, it has been used very little in the United States so far. In part this may be because it has not received much attention from agricultural educators, in contrast to systems with high use of concentrates. Success stories such as the Moores' may focus more research and extension efforts on intensive rotational grazing and encourage other dairy farmers to experiment with it.

Note on sources. This article is based on a visit to the Moore farm in Spring, 1987, and later telephone conversations, and on private communications with Bill Murphy and Henry Swayze. Data on milk production are from Dairy Herd Improvement Association reports (Cornell University). Background material on the Voisin system is given in the following references:

1. Murphy, Bill. 1987. Greener Pastures on Your Side of the Fence: Better Farming with Voisin Grazing Management. Arriba Publishing, Colchester, Vermont.
2. New Zealand Society of Animal Production. 1987. Livestock Feeding on Pasture. Ruakua Agricultural Research Center, Private Bag, Hamilton, New Zealand.
3. Voisin, Andre. 1989. Grass Productivity. Philosophical Library, New York (1959). Reissued by Island Press, Covelo, California.

Michigan State University expands sustainable agriculture program

Based on a $2 million endowment from the Charles Stewart Mott Foundation of Flint, Michigan, the Michigan State University will expand its program on balancing sound agricultural and environmental practices. The funds will be used to create a professorship in sustainable agriculture and competitive fellowships for four graduate students.

"Ground water contamination, soil erosion, and health problems linked to pesticides are signs that modern agricultural methods may not be good enough for the future," comments Elder Paul, Chairman of the Department of Crop and Soil Sciences, where the new professorship will be based.

Jane Brody's Nutrition Book. A Lifetime Guide to Good Eating for Better Health and Weight Control by the Personal Health Columnist of the New York Times. Revised and updated. 1987. By Jane Brody. Bantam Books, Toronto, New York, London, Sydney, Auckland. 552 pp.

In the reviewer's opinion, the practical significance of this remarkable book for the food producers of U.S. agriculture derives from the facts that (a) it recommends in clearly stated terms that many U.S. citizens should, for health and scientifically based nutritional reasons, make major changes in the kinds and relative amounts of foods they eat, (b) this message is aimed toward a large health-conscious segment of the U.S. reading public which appears likely to be receptive to it, and (c) the book is exceptionally well organized and written.

Other informational sources bearing the same general message also seem likely individually and in the aggregate to represent parallel potent forces for change in the future dietary habits of the U.S. public and for resulting changes in demand for particular kinds of food products. Ms. Brody's book itself, however, is an especially persuasive document and will probably influence not only its own non-nutritionist readers but also the specialist writers of many other books and articles as well.

Jane Brody combines a strong and up-to-date knowledge of the science of human nutrition with a keenly intuitive understanding of the psychological forces underlying the dietary habits of the U.S. public.

Her book describes and presents practical solutions for diet problems which many readers will recognize as causes of nagging unresolved difficulties in their own households. They will find information conveniently segregated into chapters dealing with the special nutritional needs of the pregnant woman, the infant, the child of grammar school age, the adolescent, the middle-aged person, and the senior citizen, but also segregated according to the nature of the food components involved.

The homemaker on the way to the food store, in particular, is presented with many problems and puzzling situations in the choice of items to buy. In part, confusion comes from the fact that some companies that prepare, package, and promote the sale of food products may at times allow their zeal for commercial success to take precedence over concern for major health interests of the consumer. The food buyer realizes that he or she may be subjected to this sort of biased influence but may not know where an unbiased source of information is available. Jane Brody's book represents just such a needed practical resource. The following food choice-related topics are discussed in it in a manner which can be helpful to the food buyer.

Saturated fat in excessive amounts in the diet is now agreed by most nutritionists to increase risk of heart attack and stroke, a point the food buyer might find it prudent to relate to her or his own family situation. Such fats are often derived from beef, pork, whole milk, butter, margarine, and cheese. Fish and poultry tend to be lower in saturated fat and so from the health standpoint may constitute more desirable choices. Some individuals avoid whole milk, using skim milk in its place. A soybean-derived substitute for ice cream which is very much lower in saturated fat than ice cream is available in many food stores throughout the U.S. Fat in the diet, according to sources in the National Institutes of Health, may also lead to increased risk of cancer. In some stores, foods with high content of undesirable constitutents are being labelled to alert the consumer to this fact.

Sugar in high amounts in the diet eaten by many of us not infrequently constitutes a major source of calories. It tends to cause tooth decay and, more importantly, obesity, the latter with its many accompanying health problems. Sugar is particularly harmful also to a significant segment of the population which is sugar-sensitive; it may increase heart risk in this group. High-sugar diets in addition are thought to be related to the occurrence of diabetes. Ms. Brody warns of many commonly encountered high-sugar items to avoid. An eight-ounce bottle of non-diet soft drink, according to her, can contain as much as 6 teaspoons of sugar. Cakes and pies are obvious sources. Sugared breakfast foods are often extremely high in sugar. Ketchup is also very high in sugar.

Salt is another dietary component to be on guard against. It tends to increase blood pressure and risk of stroke, also fluid retention and heart risk. Canned vegetables often contain large amounts of added salt, their fresh counterparts being much lower in salt and on this account frequently more health-compatible purchases. Pickles, olives, ham, and other high-salt items may be undesirable. Many of us, according to Ms. Brody, consume 2-4 teaspoons of salt per day, whereas a very much lower amount is adequate for our basic need.

Iron deficiency is fairly common in the U.S. population, this especially in pre-menopausal women. Iron tends to be absorbed better from animal sources than from plant products. The problem of severe iron deficiency in any individual case, however, may be complex and best dealt with under medical supervision.

Calcium may be of special concern to prevent bone degeneration in older people, especially women. Good sources of calcium are found in milk, yogurt, cottage cheese, and broccoli.

Fiber in the diet is generally low in calorie content. It tends to absorb water and be a desirable source of indigestible bulk, leading to satiety without excessive calories and to good intestinal regularity.

Vitamin needs may not be adequately supplied in the haphazardly chosen and/or faulty diets which many of us consume, according to Ms. Brody. She suggests that the best remedy is usually a more properly chosen diet rather than pills from the drugstore. Her chapter on vitamins supplies a thorough treatment of this subject, including, among other features, a dicussion of several commonly held misconceptions.

Nutritionally important trace minerals may be removed during the processing of foods. For this reason, for example, bread made from less refined flours may be more desirable than bread from the more refined flours.

Nitrate and nitrite levels may vary quantitatively from one drinking water source to another and from one food to another; there are some grounds for suspicion that higher levels might be associated with elevated cancer risk even though such elevated risk seems not to have been proven from direct evidence. Nitrites are convertible under some circumstances into nitrosamines, and these have been shown in experiments with many experimental animals to be highly tumorigenic. Nitrites and nitrates have been used for centuries in the curing of meats; they provide the pink color in hot dogs, cold cuts, and ham that are considered desirable by consumers. Some plants accumulate nitrate; variable but generally rather lesser levels of nitrate may be found in spinach, beets, radishes, celery, eggplant, carrots, etc. Because the cured meat products mentioned above may contain not only high concentrations of nitrite but also much saturated fat and sodium, Ms. Brody finds it possible to recommend against their use, even though in other food products she avoids judgmental comment in respect to association of nitrate/nitrite levels with health risk.

Weight control is a subject we hear about frequently on our TV sets and read about in the print media. Much of the advice given seems more strongly oriented, however, toward financial rewards for the advertiser than toward reasonable and safe control and reduction measures for the individual. Ms. Brody presents much sensible advice for the person in need of a moderate weight control program. Her book contains numerous recipes to help the homemaker toward the goal of a nutritionally adequate weight control diet.

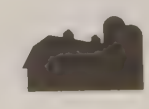
Water quality has some rather uncertainly established but possibly important relations to health. Perhaps the most potentially important of these relates to the finding that heart attack rates have been observed to be lower in areas having hard water than in those where the water is soft. Another heart-risk quality relates to the presence of trihalomethanes in some drinking water. These are organic compounds formed when chlorine being used to kill bacteria in the process of water purification reacts with organic material present in the water. Trace amounts of pesticides present as residues in the water have been alleged to represent a cancer risk, although this point seems not to have been clearly proven.

The use of the term "organic" in connection with the marketing of food products is discussed in some detail by Ms. Brody in a chapter entitled "Health Foods: Are They Healthier?" Whether entirely reasonably or not, she offers a quite disapproving comment on organic foods. She alleges that a common sequence of events seems to be that food products are produced under conventional conditions, are bought at wholesale by an intermediary with little or no knowledge of their production history, then are simply labelled as "organic" and sold at inflated prices and under circumstances in which the purchaser assumes he is buying a product of superior health safety and/or nutritional quality. In actuality, according to Brody, foods purchased as "organic" have as much pesticide residue as conventional ones and no proven basic nutritional superiority. Some organic producers would doubtless contest the accuracy of Brody's basic information about organic foods, pointing out that many of them have for years adhered strictly to organic practices in their farming and that some of them are currently engaged in the direct marketing to the ultimate consumer of produce conspicuously labelled to guarantee its organic origin.

Use of the term "natural" in the sale of foods through conventional outlets is also the subject of disapproving comment in the book. Ms. Brody makes the point that even though the term is recognized by sellers to have much sales appeal, many components of natural occurrence in foods may be nutritionally undesirable or harmful, this especially when consumed in large amounts. Many foods labelled as "natural," for example, are actually moderately or very high in fat, sugar, calories, and/or salt, all of which have a potential for producing undesirable health consequences when ingested in high amounts.

Many sources of information currently suggest that a not-inconsiderable portion of the U.S. public is at present trying some sort of dietary modification, sometimes to attain a slimmer and more attractive figure, sometimes for health reasons. Newspapers, magazines, and books are especially involved. The trend is in part toward semi-vegetarian diets but also toward fish and poultry, more fiber, fewer calories. For insight into just what is going on at present in this matter of dietary change and what may be expected in the future, the reviewer suggests reference to Ms. Brody's book.

The direction and degree in which dietary trends may influence overall U.S. domestic demand for different kinds of foods in the future is not a subject considered in the Brody book, but the interested agricultural food producer may make some informed guesses from the book about probable future developments in this regard. -- *P. B. Marsh, Consultant, Institute for Alternative Agriculture, Greenbelt, MD.*



Abstracted by William Lockeretz

Research reports

Tropical legumes for green manure. I. Nitrogen production and the effects on succeeding crop yields. K. C. Reddy, A. R. Soffes, and G. M. Prine. *Agronomy Journal* 78:1-4 (1986).

Tropical legumes for green manure. II. Nematode populations and their effects on succeeding crop yields. K. C Reddy, A. R. Soffes, G. M. Prine, and R. A. Dunn. *Agronomy Journal* 78:5-10 (1986).

These two papers are based on research conducted in Florida that was intended to address two common problems on sandy soils in the Southeast: poor nutrient status, especially in N, and the high cost and incomplete effectiveness of chemical control of several species of nematodes that are serious parasites of crops. Because there are no grain crops that both have a low N requirement and are resistant to nematodes, 7 tropical legumes and a marigold were investigated as green manures to be grown in rotation with cereal grains and other crops. The legumes included pigeonpea (two varieties), mungbean, showy crotalaria, hairy indigo, jointvetch, and velvetbean.

Each green manure was grown during three different periods each year from 1979 to 1981: early summer (April 15 - August 15); full summer (April 15 - September 15); and late summer (June 7- September 15). Summer fallow was also a treatment. For some growing periods and years, treatments were also split between soil fumigation for nematode control, and no fumigation. Crops grown after the green manure included rye, ryegrass and snap bean in the fall, and corn, wheat, snap bean and soybean the following spring.

The green manures differed substantially in their yield of N, ranging from over 200 kg/ha for showy crotalaria and one pigeonpea variety down to about 30 for mungbean and marigold. For several, N yield did not vary with growing period, while for others either full season or early summer was preferable. Fumigation increased the green manures' dry matter production, but not N yield. Fumigation did not improve the yield of the subsequent ryegrass crop, but for three legume green manures it did increase the subsequent corn yield. This was presumably a result of carry-over nematode control rather than N. It was expected that adding inorganic N would cause some of the immobilized N in the green manure to become available. However, this did not happen: wheat showed a similar response to inorganic N following all green manures and fallow.

The various treatments differed sharply in their ability to control certain damaging nematode species. Unfumigated fallow and mungbean were ineffective, allowing the root-knot nematode to increase from a low initial level to a high level in the subsequent corn and snap bean crops. Even with fumigation, these treatments failed to control root-knot nematode in corn. The other legumes and marigold achieved better control.

Sting nematodes were initially at a low level, and were kept under control by fumigation during the growth of all green manures and subsequent crops. Fallowing and green manures also gave good control without fumigation, with some exceptions. The population of lesion nematode in the soil remained low under all treatments. However, lesion nematodes in the roots of snap beans were higher without fumigation: velvetbean was the worst in this regard. Similarly, fumigation reduced the population of nematodes in the green manure itself, especially in showy crotalaria.

A more detailed study was made of snap bean because it is highly susceptible to root-knot nematode. Yield was significantly increased by those green manures that had a higher N yield. It decreased sharply with higher root-knot nematode levels. Populations of other nematodes had a less noticeable effect.

The authors conclude that with the right choice of summer legumes in a multiple-cropping system, it should be possible to control plant-parasitic nematodes and make available a large amount of biologically fixed N. This in turn could permit high yields to be achieved without fumigation and with low N fertilizer applications.

Ohio calls for certification of organic products

The Ohio Department of Agriculture has developed new regulations which define "organic" production and call for the certification of production methods by anyone using the word in advertising, promotion, packaging, or labeling of foods or feed in the state. The regulations became effective May 5, 1989. For more information contact Willie Verhoff, Ohio Department of Agriculture, Division of Marketing and Communications, 65 South Front Street, Columbus, OH 43215-4193.

Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management is the proceedings of the October, 1988, conference of that title sponsored by the Freshwater Foundation, Extension Service, and others. Presentations focus on usable, practical information resources and model programs. The 416-page book is $38.50 from the Foundation, 2500 Shadywood Road, Box 90, Navarre, MN 55392.

On-Farm Research 1988 is a practical report on low-input systems using rotations on nine demonstration farms in southwest Ontario. The 24-page booklet is from Resource Efficient Agricultural Production-Canada, Box 125, MacDonald College, St. Anne de Bellevue, Quebec, H9X 1C0.

CIKARD News is a new publication of the Center for Indigenous Knowledge for Agriculture and Rural Development at Iowa State University, Ames. The first issue defines "indigenous knowledge" as "local knowledge that is unique to a given culture or society." It is a phrase most often used in the context of aid to other nations which have native agricultures quite different from American systems. The issue lists meetings, publications, and other news. For information contact CIKARD News, 318B Curtiss Hall, Iowa State University, Ames, IA 50011.

Voisin Grazing Methods, a 30-minute video tape designed as an introduction to Voisin intensive grazing methods, has been produced by Dr. Bill Murphy at the University of Vermont as part of a LISA program grant. Murphy and two farmers practicing the method discuss its assets. Murphy projects that the system could significantly multiply the productivity of the 14 million acres of Northeast pasture. For information contact Murphy at the Department of Plant and Soil Science, the University of Vermont, Burlington, VT 05405.

1989 State of the States report analyzes sustainable agriculture and food safety programs along with state programs in forest management, solid waste recycling, drinking water, and growth and the environment. Eight states now have formal "sustainable agriculture" programs, it reports. They are California, Iowa, Minnesota, Montana, Nebraska, Ohio, Texas, and Wisconsin. Seven states earmark funds specifically for integrated pest management (IPM) programs - California, Connecticut, Delaware, Massachusetts, New Jersey, New York, and Texas. The 49-page report is $20 from Renew America, 1001 Connecticut Avenue, NW, Suite 719, Washington, DC 20036.

Fruit, Berry and Nut Inventory contains descriptions of 4,140 fruit, berry, and nut varieties with a coded list of every U.S. company that offers each one. The 366-page book is $19 (softcover) and $26 (hardcover), postpaid, from the Seed Savers Exchange, Rural Route 3, Box 239, Decorah, IA 52101.

Suppliers of Beneficial Organisms in North America, from the California Department of Food and Agriculture, lists 60 companies that sell biological controls. The emphasis in the catalogue is on scientific use of biological organisms to control specific pests. Single copies are free from the California Department of Food and Agriculture, Biological Control Services Program, 3288 Meadowview Road, Sacramento, CA 95832.

Improving Your Irrigation with Gypsum Blocksis a video designed to go with the booklet *Managing Irrigation with Gypsum Blocks*, both produced by Inform, Inc. The method was used in three years of field tests in California to achieve dramatic reductions in water use on surface-irrigated fields of alfalfa, corn, cotton, and tomatoes. The video is $35 plus $2.50 postage. Contact Inform, 381 Park Avenue South, New York, NY 10016.

Healthy Harvest III, a directory of over 1,000 sustainable agriculture and horticulture organizations, is now available in a revised 1989-1990 edition. Contact persons are listed. Copies are $18.25 from the Potomac Valley Press, 1424 - 16th Street, NW, #105, Washington, DC 20036.

The Alternative Animal Enterprises series from the Minnesota Extension Service has added five new titles: *Rabbits* (AG-FS-3698), *American Buffalo* (AG-FS-3688), *Economics of the Dairy Goat Business* (AG-FO-3606), *Sheep--An Alternative New Income Source* (AG-FO-3691), and *Marketing Alternative Animal Products* (AG-FS-3692). The publications on dairy goats and sheep are 50 cents each; the others are 20 cents. Order by title and number, with checks payable to the University of Minnesota, from the Distribution Center, University of Minnesota, 3 Coffey Hall, 1420 Eckles Avenue, St. Paul, MN 55108.

Also from the Alternative Plant and Animal Products Center are the proceedings of three symposia: *Commercial Field Production of Cut and Dried Flowers* has 25 papers from experts; *Shiitake Mushrooms* has 21 papers including information on start-up and regional updates; *Grain Legumes as Alternative Crops* has 21 papers on such crops as adzuki bean, peanut, mung beans, etc. Each publication is $20, including postage, from Extension Special Programs, University of Minnesota, 405 Coffey Hall, 1420 Eckles Avenue, St. Paul, MN 55108.

Agriculture and Groundwater Contamination: Exploring the Issues, a videotape from the Cooperative Extension Service at Michigan State University, gives an overview of nitrate and pesticide contamination from farm fields in that state. For information contact the Agriculture and Extension Education Resource Center, 10 Agriculture Hall, MSU, East Lansing, MI 48824.

Organic Gardening and Pest Control, from the University of Georgia Cooperative Extension Service, is an 18-page booklet which explains insect, disease, and weed control and general good management practices for organic gardening. Single copies free (while supplies last) from Burton Evans, Extension Entomologist, CES, University of Georgia, College of Agriculture, Athens, GA 30602.

Reaping the Revenue Code: Why We Need Sensible Tax Reform for Sustainable Agriculture, from the Natural Resources Defense Council, looks at the connections between the Internal Revenue Code and environmental conditions in agriculture. The report urges repeal of the water depletion allowance available for irrigation practices that exhaust ground water reserves. It also suggests: conditioning certain farm business write-offs on producers' commitment to minimum conservation standards for soil, water, and wetland protection; an excise tax on pesticides and fertilizers to fund research and education on farming systems that reduce chemical applications; and improvements in state property tax laws designed to protect prime farmland from urban encroachment. The 142-page book is $10 from the NRDC, 1350 New York Avenue, NW, Washington, DC 20005.

Evaluating the Effectiveness of Information Dissemination in the 1987 Integrated Farm Management Demonstration Project, by Cheryl K. Contant of the University of Iowa, reports conclusions and recommendations from an evaluation of the 1987 crop year demonstrations in that Iowa program. For information contact Extension Communications, 103 Morrill Hall, Iowa State University, Ames, IA 50011.

USDA Bibliographies on Double Cropping and Interplanting (Q.B. 89-14), Organic, Low-Input or Sustainable Agriculture (Q.B. 89-15), and Rotational Grazing and Intensive Pasture Management (Q.B. 89-16) are available. Send a self-addressed label to Reference Branch, Room 111, National Agricultural Library, Beltsville, MD 20705.

Land Husbandry: A Framework for Soil and Water Conservation is a new handbook from the Soil and Water Conservation Society which explains how to integrate soil and water conserving measures on steep lands, especially those in Third World countries where land degradation threatens farm sustainability. The handbook emphasizes short-term production benefits and participation by landholders. It is $12 postpaid from SWCS, 7515 NE Ankeny Road, Ankeny, IA 50021-9764.

International Conference on Sustainable Agricultural Systems: Workshop Suggestions on Policies and Strategies is a 9-page summary of ideas from the September, 1988, conference in Columbus, Ohio. For information contact the Rodale Institute, 222 Main Street, Emmaus, PA 18098.

1989 Organic Wholesalers Directory and Yearbook lists food wholesalers, farm suppliers, support businesses, certification groups, publications, definitions, and more. Copies of the 150-page directory are $19.50 plus $2.50 shipping and handling (and $1.17 sales tax for California residents) from the California Action Network, P.O. Box 464, Davis, CA 95617.

Acres Australia is a new quarterly journal of sustainable agriculture designed for Australian producers. The first issue focuses on remineralization of soils and its effects on plant and animal health. The publication is $18/year from Acres Australia, P.O. Box 314, Hindmarsh, South Australia 5007.

Alternative systems did well in '88 drought, South Dakota study says

An alternative farming system was the only net profit producer out of two sets of conventional and alternative systems studied during the drought of 1988, reports economist Thomas Dobbs of South Dakota State University. Although the yields of all systems studied at the state's experiment station were dramatically lower than in 1987, one alternative rotation system was a break-even operation economically and the other produced the equivalent of nearly $5,000 in net income, on a hypothetical whole-farm basis.

The profit-making system was part of a 4-year rotation of oats, alfalfa, soybeans, and corn; the break-even system was in a rotation of oats, clover, soybeans, and spring wheat. Neither alternative system used any synthetic chemical fertilizers or herbicides. The two systems were compared to conventional, ridge till, and minimum till rotations of corn, soybeans, and spring wheat or barley. In 1987, one conventional system showed the highest net income.

The key factor for success in the alternative system in 1988 was the drought-induced high price received for alfalfa hay, Dobbs reports. Final conclusions about the relative performance of systems will demand continued study under a variety of weather conditions, he cautions.

Majority of consumers interested in organic food, Organic Gardening says

In a Harris poll commissioned by Rodale Press' *Organic Gardening* magazine, 84 percent of consumers surveyed say they'd buy organic produce if it cost the same as conventional produce. More than 58 percent said they'd buy it even if it cost more. Almost half of the 1,250 consumers surveyed said they've eaten organic produce, generally in response to concern about long-range health effects. For more information contact Organic Gardening, 33 E Minor Street, Emmaus, PA 18098.

Urges expanded view of sustainability

In recent years the concern over agricultural sustainability has grown as the combination of practices termed conventional has become more obviously suspect. It is my concern that agricultural sustainability be discussed in the fullest light possible and by the broadest complement of interested parties. It should *not* be defined only in the context of measurable parameters; it also grows both from human imagination and from a broad, holistic, and personal style of education. Any definition will, of course, fall short of the reality of what sustainability is.

In identifying limits to potential sustainability of agricultural systems, the most critical variables are not those definable in economic terms but rather those arising from ecological entities and relationships. I should note here the derivations of the words *economy* and *ecology* because these are the suppositions from which views of sustainability necessarily arise. *Economy* is formed from Greek roots, *oikos* and *nomos*, meaning "management of the household." *Ecology* is also a combination from the Greek, *oikos* and *logos*, denoting "rationale of the household." Thus, my proposed tenet is that sustainability is ecological - it derives from inherent properties of the "household," not from its "management."

This approach implies that good management requires intimate knowledge of the ecology of the system and an intuitive perception of when the system is "right." And it requires awareness of and action on the degree to which intervention is possible without creating substantial instability and disequilibrium in the system. Simply, management does *not* imply control.

To the degree that we can accurately interpret archeological and fossil evidence, we can say that the most sustainable human systems were those of small groups of hunter-gatherers dispersed within the ecological resource. Such conditions, with a limited human population, may have been maintained for several hundred thousand years. The oldest agricultural systems may have been, at the outside, in existence for several thousand years. The difference in scale is obvious.

Agricultural practices which are commonly thought to have greater potential sustainabilities have been classified in recent decades with titles such as low-input, organic, ecological, regenerative, or biological. Many practices called conventional have grown apparently less and less sustainable. In fact, the sustainabilities of *all* these approaches may pale in the arena of millenia. In constructing agricultural systems, humans have affected both the flows of resources and the compositions of gene pools. It may be these changes were necessary, but there are few assurances (except the passage of time) that any or all of them is sustainable.

Sustainability must be viewed in another way. It is the physical expression of whole-hearted exploration of the mystery surrounding human existence and transcendence. The ancient hunter-gatherers, and some early agriculturalists may have known this. Many of their rituals apparently focused on the human relationship to earth, water, sky, and heaven and to the multitude of living companions those peoples knew. Their purpose seems to have been to sacredly affirm those fellowships. Their effect may have been to ensure the long-term continuance of those ties. Science cannot replace those functions; it does not affirm sacredness. There may very well be modern examples of such spiritual intimacy with the earth and its creatures. These need to be left intact and working.

This letter to the agricultural community is an attempt to expand the focus of reflections on and actions toward sustainability.

Rick Williams
Assistant Professor of
Agriculture/Biology
Ferrum College
Ferrum, VA 24088

LETTERS TO THE EDITOR INVITED

The AJAA welcomes letters, short or long, commenting on articles in this journal or sharing ideas likely to be of interest to other AJAA readers. Since our space is limited, we do reserve the right not to publish all letters or, at times, to publish only excerpts from them. To take part in this exchange of ideas, write to: Editor, AJAA, 9200 Edmonston Road, Suite 117, Greenbelt, MD 20770.

AJAA calls for manuscripts on "consequences beyond the farm gate"

Manuscripts dealing with the consequences of alternative farming systems beyond the farm gate are welcomed for a special issue of the *American Journal of Alternative Agriculture*. Examples include:

- the demographic, economic, and social consequences for rural communities;
- the consequences for manufacturers and suppliers of farm inputs;
- the effects on agricultural structure (e.g. farm size, specialization, and land tenure) and the relative roles of capital, labor, and management;
- interactions with federal and state programs;
- appropriate strategies for research, teaching, and extension; and
- implications for U.S. agricultural trade.

Papers may report original research or present a carefully developed, well-supported analysis of a policy issue.

Deadline for manuscripts is December 1, 1989. Papers accepted after external review will be published in the AJAA in Volume 5 (1990). Submissions should follow the regular guidelines for AJAA manuscripts found on the inside back cover of every issue. We welcome informal inquiries about the suitability of particular topics.

For further information, contact Dr. Garth Youngberg, Editor, at the Institute for Alternative Agriculture, 9200 Edmonston Road, Suite 117, Greenbelt, MD 20770.

Funding received for 1989 Symposium issue

Funding from Pioneer Hi-Bred International, Inc., will support publication of the papers from the 1989 IAA Symposium on "Sustainable Farming Systems." The symposium included an address by Dennis Keeney of the Iowa State Leopold Center for Sustainable Agriculture on components of sustainable systems and multiple papers on low-input systems. A separate section of papers addresses policy needs to support a more sustainable agriculture.

"Publication of these papers is particularly important in light of the forthcoming 1990 farm bill discussions," comments AJAA Editor Garth Youngberg.

Pioneer Hi-Bred was one of the original supporters of the *American Journal of Alternative Agriculture* with a substantial grant that helped launch the publication.

"Learning From Each Other" is theme of 1990 IAA Symposium

"Learning from Each Other: New Models for Sustainable Agricultural Research and Information" will be the theme of the March 6, 1990, Symposium sponsored by the Institute for Alternative Agriculture. Speakers will address the challenge of achieving a new level of cooperation between farmers, extension agents, researchers, and educators in American agriculture. The promise of on-farm research and the cooperative models being used in some LISA projects will be part of the agenda.

Dr. Richard J. Sauer, President and Chief Executive Officer of the National 4-H Council, will co-chair the symposium program committee with Dr. Youngberg. Dr. Sauer was previously the interim President of the University of Minnesota and had been Director of the Agricultural Experiment Station at that university.

"It is important for the sustainable agriculture movement to develop participative models for research, education, and information exchange in place of the 'top-down' process of the past," says Youngberg. "Farmers who have depth of experience in low-input methods can share important insights and practical experience which are likely to be trusted by other farmers. At the same time, active involvement with researchers and extension agents can give growers a better understanding of the scientific aspects of what is happening on their farm. All members of the farming team have much to learn from each other."

Further information on the symposium will be available from the Institute in early 1990.

IAA testifies on LISA funding

IAA Executive Director Garth Youngberg has given testimony to the Senate Agriculture Appropriations Subcommittee in support of the USDA Low-Input/Sustainable Agriculture (LISA) program, asking for a FY1990 budget allocation of $15 million. He emphasized the importance of the participative process involved in LISA projects, where public and private sector cooperation is strong, and farmers, researchers, and educators join forces.

Based on the call for more intensive research in biologically based pest control at the 1988 IAA Symposium, Youngberg also asked the Senate Subcommittee for $8 million funding in this area.

Despite the broad support for the LISA program, the Administration budget proposal did not include an allocation for the new program, so the Congress will need to act to include it in the FY1990 budget. The 1989 LISA allocation was $4.45 million, and the original 1988 allocation was $3.9 million. Supporters argue that it would have taken about $16 million to fund the excellent project proposals submitted in 1988 alone.

UPCOMING EVENTS

August 22. University of Nebraska's Ninth Alternative Farming Systems Field Day and Farm Tour, co-sponsored by the Nebraska Sustainable Agriculture Society. Contact Warren Sahs, Agricultural Research and Development Center, Mead, NE 68041. The Center's phone number is (402) 624-2275.

September 7-8. Regenerative Agriculture Association's Sixth Annual Thompson Field Days at the Dick and Sharon Thompson farm near Boone, Iowa. Contact Thompson Field Days, RAA, 222 Main Street, Emmaus, PA 18098. Phone (215) 967-5171.

September 6. Organic Vegetable Production for a Marketing Co-Op, Blue Heron Farm, Lodi, NY, 12-4 p.m.

September 10-15. Sustainable International Development Workshop, co-sponsored by the Institute of International Agriculture and the Michigan State University Department of Resource Development, at the Kellogg Biological Station of MSU. The workshop will demonstrate application of computer-assisted information systems for resource assessment, project planning, and implementation. Differences between more and less sustainable farming systems will be analyzed. The program is designed for professionals in international development. Contact Dr. George Axinn, Department of Resource Development, Michigan State University, East Lansing, MI 48824.

September 13. Organic Apples and Other Fruit, Hepworth Farm, Milton, NY, 12-4 p.m.

September 20. Composting on a Commercial Scale, Moody Hill Farm, Amenia, NY, 12-4 p.m.

Fees charged. Contact Pat Kane, NOFA-NY Secretary, at (607) 648-5557.

September 24-27. Expanding the Future of the Small Farm: What Works!, sponsored by Farmer's Home Administration with University Extension, University of Missouri-Columbia, Lincoln University, and Missouri Department of Agriculture. This interactive three-day program will provide practical knowledge to enhance skills and networking capabilities for service providers to the small and limited resource farmer. Contact Mary Leuci at (314) 882-2937.

October 8. Farmer Participation in Research for Sustainable Agriculture, sponsored by the Kerr Center for Sustainable Agriculture at the University of Arkansas in Fayetteville. Topics include influencing the research agenda at land grant institutions, on-farm research methodology, appropriate topics and funding for on-farm research. For information contact Marcie Brewster at the toll-free number of Appropriate Technology Transfer for Rural Areas (ATTRA): (800) 346-9140.

October 17-19. FOCUS Conference on Eastern Ground Water Issues, sponsored by the Association of Ground Water Scientists and Engineers, in Kitchener, Ontario, Canada. Conference papers will include agricultural and domestic impacts on ground water. For information contact FOCUS Eastern Conference, National Water Well Association, P.O. Box 182039, Department #017, Columbus, OH 43218.

October 20-22. National Citizen's Conference on Groundwater, sponsored by the Environmental Policy Institute, in Des Moines, Iowa. The conference includes workshops on health impacts of groundwater contaminants, low-input agriculture, hazardous waste reduction, and more. Its objective is strengthening a network of citizens capable of ensuring the wise stewardship of the country's underground water resources. Contact EPI, 218 D Street, SW, Washington, DC 20003.

November 2-4. The Place of Values in Food, Agriculture, and Environmental Systems, sponsored by the Agriculture, Food and Human Values Society, in Little Rock, Arkansas. Topics include farming, nutrition, and public policy. Contact Dr. Carolyn Sachs, Department of Rural Sociology, Pennsylvania State University, University Park, PA 16802.

Summer-Fall. Farm Field Days on Organic Farming and Composting, a series of on-farm field days sponsored as a joint effort of NOFA-NY, Cornell Cooperative Extension, Northeast Organic and Sustainable Farmers Network, and others. Discussions, tours, and demonstrations by farmers concerning their management practices, special solutions to avoid the use of toxic chemicals, marketing, and labor.

New Jersey launches organic certification program

A statewide certification program for organic growers has been announced by a food industry group that includes organic farmers and representatives from Rutgers University and the state department of agriculture. According to Dr. Gerald Berkowitz of Rutgers, the program will be administered by a board elected by the Natural Organic Farmers Association of New Jersey (NOFA-NJ). The group distinguishes organic foods as those grown without synthetic farm chemicals, but also as food produced by methods that promote the biological health of the soil. For more information contact NOFA-NJ, R.D. 1, Box 263A, Pennington, NJ 08534.

OPINION—continued from page 2

Fall: Harvest and grain handling

On a conventional corn-soybean farm, all crops are harvested in the fall. Here, good harvest management means timeliness. Timeliness, on medium to large farms, entails large, modern equipment to harvest, move, and condition the crop, plus considerable storage capacity and perhaps extra labor.

Contrast the capital requirements of this approach to a typical organic farm, again of medium to large size. Because of the more diversified crop mix, a substantial portion of the cropland is in pasture, legumes, and crops harvested in the summer. This reduces the pressure for timeliness in the fall and, therefore, also reduces the need for expensive harvest equipment. The decision to diversify, therefore, by itself reduces costs. Of course, this saving is partly offset by the organic farmer's hay handling equipment. However, reducing the size of a combine by just one size can by itself save more than the cost of a hay bailer.

Winter: Preparing harvested row crop fields for the next year's crop

Organic farmers are not the only ones who raise livestock. However, livestock are declining on conventional farms, whereas they are generally considered indispensable on organic farms. Therefore, the role of livestock provides an important area of contrast.

Preparing a field for the following year's crop includes preventing volunteer plants, managing crop residues, and providing adequate fertility. The conventional farmer typically addresses the first of these with herbicides, the second by residue shredders and tillage, and the third with purchased fertilizers. Each imposes cash costs.

In contrast, assume that the organic farmer has beef cattle grazing harvested row crop fields and that these cattle provide adequate financial return to justify their inclusion in the farming system. By grazing the harvested row crop fields, the cattle also are addressing each of the requirements for preparing for the next crop. They reduce volunteering by consuming the grain that causes the problem. They reduce the tillage requirement by consuming some of the residues. Finally, they contribute to fertility by converting the residue to manure. Once again, therefore, the organic farmer partially avoids some of the cash inputs or labor requirements of a conventional system because of a management decision that had another objective but provides other benefits in addition.

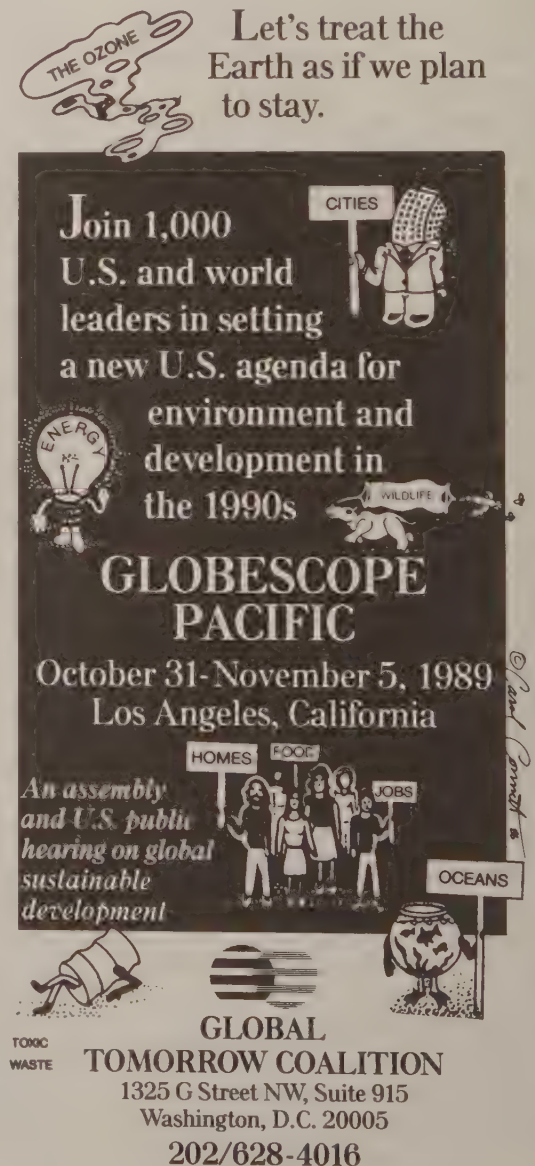
General contrast between systems: Risk management

Risk management is a central concern in evaluating competing farming systems. A conventional corn-soybean system is notoriously vulnerable to uncertainties. A farmer who is not willing to accept the risk must purchase crop insurance. Either the risk itself, or the insurance needed to avoid it, is part of the cost of production.

An organic farm, in contrast, reduces risk through diversification. Drought, for example, generally begins to threaten crops in summer. While a corn-soybean farmer is very vulnerable, on a typical organic farm one or two crops of hay have already been harvested, wheat and oats are ready for harvest, and livestock have grazed the available forage. Although this system does not avoid risk entirely, it will fare better than its conventional counterpart under severe drought. Once again, if there already were sufficient reasons to diversify, the reduction in risk is an additional benefit of a management decision.

Conclusion

I have offered five illustrations spanning the seasons and covering several basic features of a farming system, of how organic farms may eliminate some of the cash inputs of conventional agriculture not by additional labor but by how the system is managed. Indeed, in several examples, the management of organic systems replaces even the labor of a conventional system. In evaluating these competing systems, it is important to recognize the distinct way that organic systems can often solve their problems, that is, by using techniques that automatically serve additional purposes along with the primary objectives that by themselves have already covered the costs.



ATTRA: A conduit for information on sustainable agriculture

Agricultural information has been customarily transmitted through one-on-one visits to farmers by extension agents and agricultural suppliers, as well as through farm journals and magazines. While these avenues are still vital, the enormous expansion of interest in sustainable/low-input agriculture and the explosion in computer-based methods for gathering and disseminating information has led to new programs for agricultural technology transfer.

ATTRA (Appropriate Technology Transfer for Rural Areas) is one such new program. ATTRA, managed by the National Center for Appropriate Technology (NCAT) under a grant from USDA's Extension Service, was developed to provide farmers with timely information on sustainable agriculture with the help of a toll-free phone line. It is staffed by technical specialists with access to a network of researchers and farmers, computer databases, and other sustainable agriculture information sources from all over the country.

ATTRA's current mission is to provide information and technical assistance on sustainable agricultural practices and policies to farmers of all educational levels as well as to extension agents and agribusinessmen. Sustainable practices are designed to conserve and protect soil and water resources, reduce the use of pesticides, fuels and fertilizers, and improve profitability by lowering farm production costs. Future plans are to have ATTRA develop a more active role in applied research and demonstration projects on sustainable agriculture techniques.

ATTRA has proved to be an effective and economical conduit for information transfer. It is receiving about 100 calls a week from farmers, extension agents, and other agricultural specialists seeking specific material on sustainable agriculture. This figure is double the number of inquiries received in 1988. Since the program began in July, 1987, ATTRA has received over 6,000 calls.

ATTRA's technical experts cover everything from agronomy and horticulture to animal husbandry, aquaculture, and market diversification. They have answered questions that range from sustainable control of codling moths on apples to the best way to conduct aerobic composting. Calls have come in from all of the 50 states and from Puerto Rico and the Virgin Islands. Interested persons have visited ATTRA headquarters from South Africa, Asia, and Latin America. ATTRA's rapid success is indicative of the increasing interest by farmers across the country in methods that will allow them to reduce chemical inputs.

Over 40 percent of the questions ATTRA has received center on the reduction in use of agricultural chemicals in field, fruit, and vegetable crops. Fifteen percent concern animal enterprises, including animal feeds, health, and pasture management. Sustainable production techniques, crop diversification, and marketing are other major areas of interest. ATTRA also deals with questions on equipment for sustainable agriculture, fuel consumption, and water management.

Of the cases handled in one typical week, 32 concerned reduction of purchased inputs in crop and livestock production. Twenty-six callers wanted information on diversifying farm enterprises. Another 26 were interested in other aspects of sustainable agriculture, such as soil and water conservation, organic certification, and niche marketing for organic and other specialty produce. Sixteen asked general questions, including inquiries on federal funding for LISA (Low-Input/Sustainable Agriculture) research.

ATTRA users who wanted to reduce pesticide and fertilizer use particularly wanted information on biological controls. These included technologies ranging from crop rotation to the use of natural predators and pheromones.

Many farmers interested in diversification sought new ways to market their current crops. Others were seeking information on alternative enterprises, with particular attention to specialty crops like shitake mushrooms, lupine, and herbs. Since only a few pesticides are registered for each of many of these crops, growers are searching for sustainable alternatives. Diversification requests have become so frequent that ATTRA has developed a standard packet of information that can be modified to address specific needs in different areas of the country.

Many of those interested in other aspects of sustainable agriculture are part-time, small-scale farm operators requesting material on organic market gardening as well as advice on how to enter the market. There is increasing interest in using sustainable practices and biological controls for fruit production, and ATTRA has prepared special information briefs on sustainable production of blueberries, apples, strawberries, and other crops. Similar briefs of interest to field crop and livestock farmers have been prepared on topics such as low-input corn and soybean production, green manure crops, and farm-scale composting.

The rapid multiplication in numbers of ATTRA's questions has several roots. One is that the toll-free number (800-346-9140) has become better known, and ATTRA has achieved increasing name

recognition. Farmer concern about issues like ground water contamination is another cause. This concern is well documented. In a recent survey of farmer opinion on ground water in five states conducted by the Agricultural Law and Policy Institute, most farmers interviewed were concerned about ground water contamination. From 81 to 92 percent favored technical assistance to reduce chemical use.

Clearly, farmers are considering reducing chemicals as a way to cut costs. In addition, growing consumer concern about produce subjected to multiple pesticide applications has affected some agricultural pocketbooks. Farmers are beginning to see low-input or sustainable agriculture as a practical way to solve environmental and marketing problems and to decrease costs and increase profitability.

After a year of operation, it became clear that ATTRA needed the resources of a major land grant university which could supply it with access to an agricultural experiment station, library facilities, and the expertise of extension specialists. ATTRA's recent move from Memphis, Tennessee, to the University of Arkansas campus at Fayetteville has given it access to these resources and to the university's new $1.5 million alternative pest control center.

ATTRA's move has also given it proximity to other organizations devoted to low-input sustainable agriculture. ATTRA is on the same floor as the university's International Agricultural Program. Winrock International, the Ozark Organic Growers' Association, and the Meadowcreek Project, a sustainable agriculture and environmental education and demonstration center, are all close by. The Kerr Center for Sustainable Agriculture in Poteau, Oklahoma, is within 80 miles. All of these are both potential resources and users of ATTRA.

The ATTRA staff includes 16 people. Ten technical specialists take turns manning the phone lines in two-hour shifts. The calls are screened to make sure they are appropriate low-input or sustainable agriculture questions. ATTRA's staff then refers questions about conventional techniques to the Extension Service and other USDA agencies. At the end of each week, the sustainable agriculture questions are discussed by the ATTRA staff and each call is assigned to a technical specialist. Each technical specialist has a particular area of expertise, ranging from horticulture and agricultural economics to integrated pest management. However, more important than knowing the answer is knowing where to go for it, according to Jim Lukens, ATTRA's senior technical specialist.

ATTRA has its own reference library with access to hundreds of pertinent journals. It also uses several on-line databases, including CRIS (Current Research Information System), CAB, and AGRICOLA, a database created by the National Agricultural Library.

ATTRA's own files, telephone contacts, computer databases, and the university library are the major sources of information collection. Each answer is developed in three parts including: 1) a detailed letter which addresses special characteristics of the problem, 2) a section that contains articles that pertain to the subject, and 3) a list of potential resource people and groups. The response to this system of information transfer has been extremely favorable. Almost 95 percent of those who returned evaluation forms consider the assistance provided by the ATTRA staff as excellent or good.

There are some types of questions ATTRA does not answer. It cannot respond appropriately to acute problems that need immediate attention or on-site investigation. ATTRA no longer takes questions on community resource management or other rural development issues that are not related to low-input sustainable agriculture.

ATTRA has worked closely with the Extension Service to develop a program that complements more traditional extension programs. By providing both state specialists and county agents with hard-to-find information on sustainable agriculture, ATTRA assists in serving a growing extension clientele. County extension agents are important users of ATTRA's services since they provide information and technical assistance to many farmers and multiply ATTRA's effectiveness.

ATTRA received $500,000 as an operating budget in Fiscal Year (FY)87, $750,000 in FY88, and $900,000 for FY89. The FY1990 request is for $1.5 million to meet the expanding needs for new staff and for new projects. One project is development of publications on sustainable agriculture for farmers of all educational levels. Another is the establishment of a newsletter that will reach farmers, extension agents, and farming organizations throughout the country.

NCAT, the private, non-profit organization that manages ATTRA, is headquartered in Butte, Montana. NCAT also operates the National Appropriate Technology Assistance Service (NATAS), which provides technical assistance to the public on conservation and renewable energy topics.

Robert J. Gray, President, Resource Management Consultants and Program Consultant to ATTRA; and Joanne Dann, Resource Management Consultants, 1920 N Street, NW, Washington, DC 20007

ATTRA moves to Arkansas

The Appropriate Technology Transfer for Rural Areas (ATTRA) offices and hotline have moved from Memphis to Fayetteville, Arkansas, announces Nick Brown, Program Manager. ATTRA offers information and referrals to technical experts on low-input/sustainable agriculture. The new ATTRA mailing address is P.O. Box 3657, Fayetteville, AR 72702. Its hotline telephone number remains the same: 1-800-346-9140. For business other than information requests, call 501/575-7570.

Guide for authors

AJAA will publish original research on biological, physical, or social science aspects of alternative agriculture. We particularly welcome multi-disciplinary studies, but papers from a specific discipline also are invited. However, since AJAA readership is much broader than for a single-discipline journal, highly specialized terminology should be explained or avoided. The significance of a statement, or the reasoning behind a conclusion, may have to be spelled out more than in a more specialized journal. Research papers usually should be no longer than about 20 double-spaced pages.

Nomenclature and technical details

Research papers should use the International (SI, or metric) system throughout. Write out "liters". "Metric ton", although not strictly an accepted SI unit, can be used for data referring to "ordinary life," such as national crop output, as opposed to experimental data. Occasional use of common unit equivalents in parentheses is permitted, mainly for relatively exotic SI units.

The binominal or trinominal designation of a plant or animal species, and the cultivar where relevant, should be given in parentheses the first time the common name of the species is mentioned. Either name may be used thereafter. The same applies to names of chemicals that have both a common name and a chemical name. Do not use brand names except where the chemical is produced under a unique brand name. In those cases the brand name, identified as such, may be given the first time the chemical is mentioned. Nutrient applications should be given in elemental form (N,P,K). Oxide forms can be used in describing commercial fertilizers.

Title page

The title page should give the following information (all flush left): 1) title of the paper; 2) names of authors; 3) affiliation and office address of authors, and 4) acknowledgements, if any. See examples in this issue of AJAA.

Abstract

The abstract should be 200 to 400 words suitable for readers from a broad range of disciplines. It should avoid highly-specialized terminology that might be appropriate for a single discipline journal. Take particular care that the significance of the work is made clear, even to readers from a different field.

Reference list

References should be listed in alphabetical order by author's name, and by year for a particular author (with letters after the year if needed). If a sole author is also the lead author of papers with multiple authors, use the following order: single author (by year); two authors (alphabetically by second author's name); three or more authors (by year). Repeat the author's name for each reference. Use initials only for first and middle names. Give the names of all authors in the reference; never use "et al."

Use full names of journals, institutions, conferences, etc., except for extremely familiar abbreviations like "Dept." Remember that an abbreviation familiar to you may not be familiar to readers outside your field. If in doubt, write it out.

The reference list uses no quotation marks, italics, boldface, or underlining. Only the names of books and periodicals are in initial capitals. Names of papers, book chapters, pamphlets, and bulletins are not capitalized. Page numbers are written out in full (e.g., 1108-1123, not 1108-23). The volume is given if page numbers begin at 1 for each issue.

Citing references

Cite references in the text by last name and year, with chapter or page numbers if the reference is a book or lengthy report. For two authors, give both names. Do not use "et al." unless there are at least three authors.

Footnotes

AJAA does not use bibliographic or substantive footnotes. All bibliographic references should be at the end of the text. Instead of substantive footnotes, include the material in the main text or consider eliminating it.

Manuscript preparation

The entire manuscript, including abstract and references, should be typed on one side of standard-size paper, double spaced, with margins of at least one inch all around. Starting with the title page, label all pages in the upper righthand corner with the lead author's last name and the page number. Do not use hyphens unless the hyphen is part of the word. Do not underline anything except species names.

Follow the section headings style used in this AJAA issue. All headings are flush left, with no underlining or italics.

Tables should fit on one page, be numbered consecutively with Arabic numerals, and be on a separate sheet. Leave extra space to separate columns. Every figure and table should be mentioned at least once in the text.

Submission of manuscripts

Submit four high-quality copies to Editor, American Journal of Alternative Agriculture, Suite 117, 9200 Edmonston Road, Greenbelt, MD 20770. The cover letter should state that the manuscript is an original contribution that has not been published elsewhere in substantially the same form; that it is not currently under consideration elsewhere, and that permission has been obtained for any copyrighted material used.

How you can help support the scientific and educational needs of a sustainable agricultural system

A growing number of Americans have become concerned about the long-term sustainability of our food production system. Farmers and agricultural scientists are among those raising questions about the growing dependence of modern farming on nonrenewable resources, the depletion of our resource base through soil erosion, and heavy reliance on chemical fertilizers and pesticides. Continued heavy reliance on farm chemicals is questioned because they have become an expensive production input. Their widespread use also raises questions about human and animal health, food quality and safety, environmental quality, and the continued demise of the family farm.

Low-input alternative farming methods address these economic and environmental challenges. Alternative production systems point the way toward more profits, more individual choice, and long-term sustainability for our food system. More must be done to develop effective ways to make sure research, education, and information sources are readily available to farmers who want to adopt these techniques.

The Institute for Alternative Agriculture needs your help in meeting this challenge. We are a nonprofit tax-exempt research and education organization set up in 1983 to encourage and facilitate the adoption of low cost, resource conserving, and environmentally sound farming methods. We work directly with government agencies, colleges and universities, producer groups, and other institutions that provide research, education and information services to farmers.

The Institute also provides these services:

- *A resource to lawmakers and others who influence agricultural research, education, and information policy*
- *A voice for alternative agriculture in Washington*
- *A sponsor of research and education outreach programs*
- *A national clearinghouse for information on alternative agriculture*
- *A publisher of reliable scientific information on agricultural sustainability*

If you're interested in helping us, please contact our office at 9200 Edmonston Road, Greenbelt, MD 20770. The phone number is (301) 441-8777.

INSTITUTE FOR ALTERNATIVE AGRICULTURE, INC.